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AGE AND GROWTH OF BROOK TROUT IN NORTHERN BREEDER STREAMS

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It has long been a practical policy of conservation departments to establish so-called trout breeder, feeder, or nursery streams. The designation and closure of such streams to fishing is sanctioned by the sportsmen. The establishment of breeder streams has been based on the assumption that in general adult brook trout migrate upstream in the fall to seek the smaller headwater areas for spawning, and that after depositing their eggs the adults return to the larger waters downstream. The eggs are left to hatch in security, and as the fry grow they migrate downstream to replenish fishing waters. Apparently little effort has been expended in the study of breeder streams, but their closure has been accepted as an efficient method for trout management.

During the summer of 1937 biological survey crews of the New Hampshire Fish and Game Department discovered a ten-thousand-acre area containing several streams which are regarded as primitive in nature. "These streams are considered primitive because they have been neither fished nor stocked over a ten-year period, and it is believed that the fish populations would have reached primitive proportions during that period. The primitive area is located in the White Mountain National Forest in northern New Hampshire (latitude approximately 44°30′ N), and is under federal control as a watershed yielding the water supply to a federal fish hatchery. Fish from the hatchery do not escape into the streams studied" (Hoover, 1938).

Representative areas of these primitive streams were intensively seined. The efficiency of seining was ascertained by several check methods, and the pounds of trout and forage fish per acre of water were estimated (Trippensee, 1937; Hoover, 1938). For every stream studied, temperatures, altitude, average width and depth, volume of flow, velocity, turbidity, color, pH, bottom, overhead cover, shelter for fish, numbers and total volume of bottom organisms, type and frequency of pools were analyzed and recorded in more detail than in the routine stream survey. All fish collected were preserved for future study. After the efficiency of seining was ascertained the results were corrected to an estimated 100% efficiency.

NUMBER NINE BROOK

Number Nine Brook is a typical cold northern breeder stream. It drains a

[1] The author died at Concord, N. H., January 8, 1939. See obituary in THE JOURNAL OF WILDLIFE MANAGEMENT, 3(1), January 1939, p. 74.

mixed conifer-hardwood area, and is well shaded. It is believed that the water temperature in degrees Fahrenheit does not exceed the fifties (53°F. August 8). The stream was given a B pool grade,[2] and the invertebrate bottom organisms averaged .06 c.c. per square foot (average of 24 samples). 79.6 (±10%)[4] pounds of fish per acre of which 78.6 (±10%) pounds were brook trout (*Salvelinus fontinalis*), and 0.7 pounds were a companion species *Cottus cognatus*. The total estimated number of trout varied in areas studied from 1,850 to 2,600 individuals per acre.

TABLE 1

LENGTH DISTRIBUTION OF TROUT TAKEN FROM NUMBER NINE BROOK

Standard length in 10 mm. size classes	Approximate total length in inches	Number males	Number females	Total both sexes	Approximate size class per cent total
	(Short trout)				
50–59				27	
60–69	3.0–3.2	6	17	23	11
70–79	3.3–3.6	14	18	32	16
80–89	3.7–4.0	8	15	23	11
90–99	4.1–4.5	25	22	47	23
100–109	4.6–5.1	9	11	20	10
110–119	5.2–5.6	12	11	23	11
120–129	5.6–5.9	3	7	10	5
	(Legal length trout)				
130–139	5.9–6.3	4	4	8	4
140–149	6.4–6.6	3	4	7	4
150–159	6.7–7.1	3	3	6	3
160–169	7.5–7.7	1		1	1
170–179	7.7–8.1	2		2	1

The contents of trout stomachs (30 trout were used in each analysis described in this paper) collected July 27 consisted largely of terrestrial insects (79.2% terrestrial, 20.8% aquatic insects).[3] The bottom of the stream was sand and fine gravel; the average width of the stream in the area studied was 6.8 feet. Riffle areas are almost totally lacking.

On July 27, 1937, Number Nine Brook was carrying approximately

[2] Embody, G. C. Survey Genesee Watershed, N. Y. Conservation Dept., 1926.

[3] Stomachs analyzed by W. H. Behney, University of Vermont.

Few trout exceed legal length (6 inches or more); the largest trout seined in Number Nine Brook was 8 inches long. Table 1 is a record of the size distribution for all trout taken.

RATE OF GROWTH

The scales of 221 trout varying from 36 mm. to 175 mm. standard length, or from $1\frac{5}{8}$ inches to 8 inches total length, were cleaned and mounted in glycerine-gelatin (Van Oosten, 1929). The scales were studied by means of a microscopic projection apparatus. Measurements were made of the an-

[4] All poundage ±10%.

terior field of the scale; the length of the fish in mm. corresponding to each annulus, was calculated according to Fraser's modification of Johnston's formula (Hazzard, 1932) as follows:

$$x = 40 \text{ mm.} \times \frac{\text{scale length to annulus}}{\text{total scale length}} \times (\text{S.L.}^{5} - 40 \text{ mm.})$$

Scales were found to appear at approximately 40 mm. ±4 mm. in these trout. Hazzard (1932) found the calculated average length of brook trout, by use of the above formula, to be consistent with the average empirical length of age groups.

The age group 3 of the trout were found in the headwater areas of the stream in association with the 0, 1, and 2 groups. The male brook trout grows slightly faster than the female in Number Nine Brook, but no evidence is available from the population studies concerning preference of the sexes for specific stream habitats.

[5] Standard length of fish at time of capture.

TABLE 2
DISTRIBUTION OF TROUT IN NUMBER NINE BROOK BY AGE GROUPS

Age group	1	2	3
Males	52	21	10
Females	53	33	16

TABLE 3
LENGTH IN MILLIMETERS ATTAINED BY NUMBER NINE BROOK TROUT WITH SCALES SHOWING 1, 2 AND 3 ANNULI

Age group	1	2	3
Males	74.0	99.25	124.0
Females	66.0	89.5	118.7

COLD BROOK

Cold Brook lies in the same watershed as Number Nine Brook. The water

TABLE 4
LENGTH DISTRIBUTION OF TROUT TAKEN FROM COLD BROOK

Standard length in 10 mm. size classes	Approximate total length in inches	Number males	Number females	Total both sexes	Approximate size class per cent total
	(Short trout)				
30–39	1.6–1.9	7	0	7	4
40–49	1.9–2.1	9	0	9	5
50–59	2.3–2.5	3	0	3	2
60–69	3.0–3.3	1	2	3	2
70–79	3.3–3.6	14	7	21	13
80–89	3.7–4.1	10	12	22	13
90–99	4.2–4.6	6	9	15	9
100–109	4.7–5.1	7	16	23	14
110–119	5.0–5.5	10	16	26	16
120–129	5.6–5.8	9	4	13	8
	(Legal length trout)				
130–139	5.9–6.3	4	4	8	5
140–149	6.4–6.5	4	5	9	5
150–159	6.9–7.1	3	1	4	2
160–169	7.6–7.7	1	2	3	2

TABLE 5

DISTRIBUTION OF TROUT IN COLD BROOK BY AGE GROUPS

Age group	1	2	3	4
Males	24	27	9	1
Females	26	23	6	0

TABLE 6

LENGTH IN MILLIMETERS ATTAINED BY COLD BROOK TROUT WITH SCALES SHOWING 1, 2, AND 3 ANNULI

Age group	1	2	3	4
Males	65.3	90.8	122.7	146.5
Females	67.15	93.1	112.8	
Average	66.2	91.9	117.7	

temperature on August 4, 1937 was 53°F. (air, 73°F.). The stream was assigned a B pool grade and was found to be poor in invertebrate bottom organisms (average for 24 samples, 0.1 c.c. per square foot). The contents of the trout stomachs collected August 4 consisted of 6% of aquatic invertebrates, and 94% terrestrial insects. The bottom of the stream was composed of boulders (80%), rubble (10%) and gravel (10%). The average width of the stream in the area studied was 12.3 feet.

Cold Brook was carrying approximately 66.8 pounds of trout per acre. The number of trout per acre of water varied from 356 to 1,109 individuals.

Table 4 is a record of size distribution.

The scales of 166 trout were studied to ascertain the rate of growth. Table 5 and Table 6 are summaries of the data obtained.

TABLE 7

LENGTH DISTRIBUTION OF TROUT TAKEN FROM UNKNOWN POND BROOK

Standard length in 10 mm. size classes	Approximate total length in inches	Number males	Number females	Total both sexes	Approximate size class per cent total
	(Short trout)				
30–39	1.7–1.9			14	10
40–49	1.9–2.3			18	13
50–59	2.4			6	4
60–69	3.0–3.2	4	0	4	3
70–79	3.3–3.7	2	6	8	6
80–89	3.8–4.2	12	7	19	14
90–99	4.2–4.7	2	6	8	6
100–109	4.7–5.1	9	7	16	12
110–119	5.2–5.5	9	8	17	13
120–129	5.5–5.8	1	6	7	5
	(Legal length trout)				
130–139	6.0–6.2	3	6	9	7
140–149	6.5–6.8	4	2	6	4
150–159	6.8–7.1	0	2	2	1
160–169	7.2	1	0	1	1
170–179		0	0	0	0
180–189		0	0	0	0
190–199		0	0	0	0
200–209		1	0	1	1

UNKNOWN POND BROOK

Unknown Pond Brook, a tributary, is ecologically similar to Number Nine Brook. The water temperature was 57°F. on July 21, 1937 (air, 74°F.). The stream, in the specific area of seining, has a B pool grade; the invertebrate bottom organisms average 0.15 c.c. per square foot (12 samples). The stomach contents of trout taken on July 21 consisted of 11.1% fish (*Cottus* and 0 group trout); 2.3% aquatic invertebrates, and 86.6% terrestrial insects. The average width of the stream in the area studied was 10.4 feet.

Unknown Pond Brook was carrying 48.8 pounds of trout and one pound of *Cottus cognatus* per acre of water. The number of individual trout of all sizes was approximately 1,050 per acre.

TABLE 8

DISTRIBUTION OF TROUT IN UNKNOWN POND BROOK BY AGE GROUPS

Age group	1	2	3	4
Males	15	29	11	4
Females	22	40	11	

TABLE 9

LENGTH IN MILLIMETERS ATTAINED BY UNKNOWN POND BROOK TROUT WITH SCALES SHOWING 1, 2, AND 3 ANNULI

Age group	0	1	2	3	4
Unsexed	42.4				
Males		67.7	98.1	122.4	173.1
Females		68.3	86.6	107.5	

THIRD BROOK

Third Brook is likewise ecologically similar to Number Nine and Unknown Pond brooks. The water temperature was 53°F. on July 20, 1937 (air, 71°F.). The stream was given a C pool grade, and invertebrate bottom organisms

TABLE 10

LENGTH DISTRIBUTION OF TROUT TAKEN FROM THIRD BROOK

Standard length in 10 mm. size classes	Approximate total length in inches	Number males	Number females	Total sexes both	Approximate size class per cent total
	(Short trout)				
40–49	2.0			2	5
70–79	3.7	4	0	4	10
80–89	3.9–4.1	4	0	4	10
90–99	4.1–4.5	3	5	8	15
100–109	4.8–4.9	0	8	8	15
110–119	5.0–5.5	6	5	11	25
120–129	5.7–5.9	5	3	8	15
	(Legal length trout)				
130–139		0	0	0	0
140–149	6.7	2	0	2	5
Totals		24	21	47	

Tables 7, 8 and 9 are summaries of the length distribution, age groups, and growth of the trout population of Unknown Pond Brook.

TABLE 11
DISTRIBUTION OF TROUT IN THIRD BROOK BY AGE GROUPS

Age group	0	1	2
Unsexed	2		
Males		15	15
Females		1	15

averaged 0.3 c.c. per square foot. The poor food conditions are reflected in the stomach contents of trout collected on July 20 which consisted of 3.2% aquatic insects, and 96.8% terrestrial insects. Stomach analyses of trout for all streams, although the trout were taken on different dates, indicate the same general feeding conditions.

Third Brook was carrying approximately 29.7 pounds of trout or 544 individuals per acre of water. The average width of the stream in the area seined was 10.8 feet.

Tables 10, 11 and 12 are summaries of the length distribution, age groups, and growth of Third Brook trout.

TABLE 12
LENGTH IN MILLIMETERS ATTAINED BY THIRD BROOK TROUT WITH SCALES SHOWING 1 AND 2 ANNULI

Age group	0	1	2
Unsexed	43.5		
Males		68.5	97.8
Females		72.0	95.6

DISCUSSION

Age and Growth of Brook Trout

The growth of brook trout in the four streams studied is so nearly uniform that the data are combined for discussion (Table 13).

The four streams might be considered as typical cold northern breeder streams. According to conventional methods of growth calculation, male brook trout grow slightly more rapidly than the females. Differential growth of the sexes, however, is comparatively slight and a maximum difference of only one centimeter is attained (in fish of 113–123 mm. in standard length) (Fig. 1). Brook trout in these streams do not reach legal length (6 inches or more) until their fourth year of life. At the formation of the third scale annulus females average approximately 5.3 inches, males, 5.7 inches, in total length. Four-year-old brook trout (3 group) are found in association with the

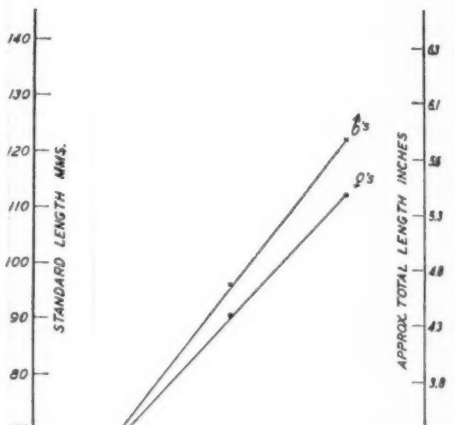

Fig. 1. Graphical representation of growth of male and female trout in the four streams studied.

0 age group in the headwaters of the smaller streams. Sportsmen frequently cite these streams as excellent trout breeder waters, well populated with fingerling trout. The fingerling trout, however, may be two or three years old. This fact may be of significance in trout

TABLE 13

CALCULATED STANDARD LENGTH IN MILLIMETERS ATTAINED BY BROOK TROUT IN PRIMITIVE STREAMS WITH SCALES SHOWING 1, 2, AND 3 ANNULI. THE FIGURES ENCLOSED IN PARENTHESES REPRESENT THE SMALLEST AND LARGEST STANDARD LENGTHS IN THE GROUP

Age group	1	2	3
Unknown Pond Brook			
Males	67.7 (61.0–75.6)	98.1 (79.7–107.2)	122.4 (100.1–139.8)
Females	68.3 (60.3–76.4)	86.6 (73.7–95.8)	107.5 (103.2–111.6)
Cold Brook			
Males	65.3 (50.3–79.4)	90.8 (70.1–177.0)	122.7 (106.4–146.0)
Females	67.1 (54.9–88.4)	93.1 (78.1–100.0)	112.8 (103.1–127.9)
Third Brook			
Males	68.5 (59.8–88.2)	97.8 (78.3–119.0)	
Females	72.0 (59.8–88.7)	95.6 (75.5–111.9)	
Number Nine Brook			
Males	74.0 (56.0–90.6)	99.0 (82.7–123.7)	124.0 (105.1–147.0)
Females	66.0 (57.8–78.5)	89.0 (71.6–119.1)	118.7 (102.2–138.8)
Average for the 4 brooks			
Males	68. (50.3–90.6)	96.4 (70.1–107.2)	123.0 (100.1–139.8)
Females	68.3 (54.9–76.4)	91.1 (71.6–95.8)	113.0 (102.2–111.6)

management because from the evidence available it appears that brook trout are comparatively short-lived and may not become available to the angler if they do not grow more rapidly than these stunted trout. Only two trout in 580 examined had four annuli. Hazzard (1932) figures a brook trout scale with five annuli. Hatcherymen, however, say it is not unusual for brook trout to reach eight years of age. There is definite need for a study of scales from trout of known ages to ascertain if the conventional methods of scale study are valid for this species.

The time of annulus formation in these trout is not well known. Dannevig and Dannevig (1937) found that so-called "winter zones" in scales of the brown trout of Norway were formed in spring, summer, fall and winter. As indicated below it is assumed from the present study, however, that in the very limited locality of these primitive streams such a variation in the time of annulus formation would not prevail.

The last zone of growth cessation occurred well in from the edge of the scales of 95% of the trout studied, and the last annulus was surrounded by an area of rapid growth. Approximately 5% of scales studied, however, had an annulus at the edge of the scale.

CONSIDERATIONS IN CALCULATION OF GROWTH

Figure 2 is a graphical presentation of the results obtained in calculating

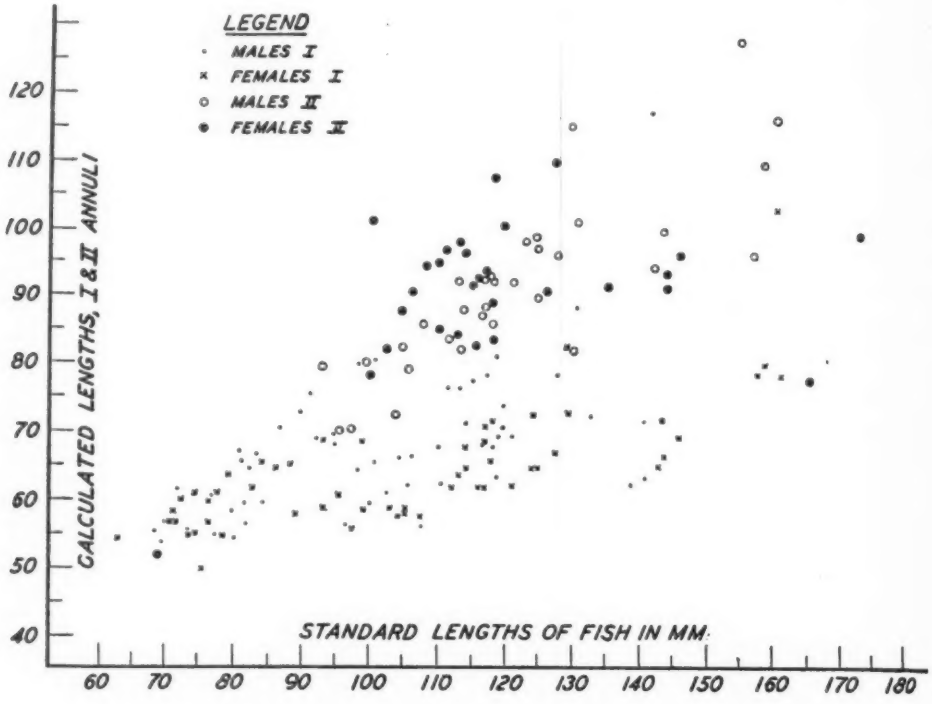

Fig. 2. Graph showing length of trout, with scales having 1 and 2 annuli, as calculated from trout of different standard lengths.

the length of trout at the end of the first and second years of life from trout of different standard lengths. It appears from the graph that the calculated length at the end of the first and second years is greater when calculated from a larger fish. These data might easily be interpreted as indicative of a changing environment, i.e., it might be assumed that each year a breeder stream is closed the competition becomes greater with a resultant decrease in growth, or

TABLE 14

AVERAGE STANDARD LENGTH OF TROUT AND AVERAGE[6] MAGNIFIED ANTERIOR RADIUS OF THE SCALE

Average standard length	Average anterior field of scale	Body/scale ratio
89.8	27.1	3.31
97.7	33.2	2.94
109.5	43.5	2.52
119.6	53.3	2.24
129.6	62.0	2.16
150.8	73.0	2.07

[6] Obtained by averaging scale lengths within 10 mm. groups and averaging standard lengths of fish in 10 mm. scale groups.

TABLE 15

AVERAGE MAGNIFIED LENGTH OF ANTERIOR FIELD OF SCALE AND MEASURED SCALE LENGTH AT FIRST, SECOND, AND THIRD ANNULI

Average length scale	Average length to first annulus	Average length to second annulus	Average length to third annulus
27.1	14.7		
33.2	18.1	26.6	28.0
43.5	19.0	23.5	38.5
53.3	19.8	34.7	42.2
62.0	21.4	41.4	51.7
73.0	26.5	48.0	64.0

more likely that the larger fish of which there are few may have grown most rapidly during their entire life.

Tables 14, 15, and 16 present evidence that the anterior field of the scale varies somewhat in length with the standard length of the fish from which it was removed (evidence only for small trout).

"Mottram found, further, that Lee's phenomenon is reversed in Dahl's calculated measurements of the trout—that is, the corresponding computed values for any one year of life are larger in the big fish than in the small. In a study of comparative growth rates Mottram, therefore, groups his salmon according to the order of size of the actual scale measurements" (Van Oosten, 1929).

TABLE 16

AVERAGE MAGNIFIED LENGTH OF ANTERIOR FIELD OF SCALE AND CALCULATED STANDARD LENGTH OF TROUT AT FIRST, SECOND, AND THIRD ANNULI

Average length scale	Calculated length trout at first annulus	Calculated length trout at second annulus	Calculated length trout at third annulus
27.1	63.2		
33.2	67.0	90.8	
43.5	69.7	92.4	115.0
53.3	69.0	91.0	116.0
62.0	67.4	90.4	116.0
73.0	73.4	102.5	131.0

THE PROBLEM OF FOOD AND TEMPERATURE

Low summer water temperature is probably a major factor in limiting the growth of trout in northern streams. Hubbs, Greeley, and Tarzwell (1932) report coldest spring water, issuing from the ground at temperatures of 43° to 52° Fahrenheit, while habitable by trout and particularly well suited to their spawning, is much less conducive to growth than considerably warmer water (60° to 70°F.). Hazzard (1933) [referring to his experience in New York] "has attributed the slow growth of brook trout in certain New York streams to low water temperature which together with the low rate of removal and highly suitable spawning conditions has resulted in overpopula-

tion with small trout." Hoover (1937b) writes, "Several factors acting jointly or individually may be responsible for this condition [short-trout streams]. The short growing season, general low water temperature, lack of food, and over-abundance of spawning areas in

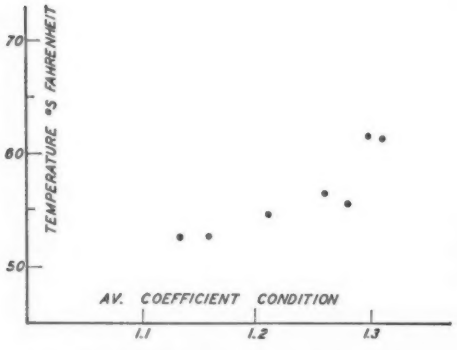

Fig. 3. Coefficient of condition of brook trout of various streams plotted against August water temperature of streams from which they were taken.

conjunction with the limited food supply and possibly other factors are of importance."

The coefficients of condition in trout (Hecht, 1916; Hazzard, 1932) in the streams studied were found to vary directly in a general way with the August water temperatures (Fig. 3). This relationship may be purely coincidental and of local application. The data are too few to warrant generalizations. Embody (personal communication) believes that the coefficient of condition of brook trout gradually increases with the water temperatures until the temperature exceeds 70°F. and then decreases.

The fact that the trout in these primitive streams are relatively deep-bodied (apparently normally fat) suggests that the growth rate may not be critically retarded by lack of food. Quite possibly as much food is taken as can be utilized advantageously at the prevailing water temperatures. During the short growing season (3½ months) the food supply is supplemented with terrestrial insects. It seems that low water temperatures are the most important factor in limiting growth.

The slow growth may be compensated for in part by a longer life span. "It has been observed repeatedly that poikilothermous organisms tend to grow more slowly and reach a greater age in northern latitudes. This phenomenon appears to depend on the relation of temperature to the rate of metabolism" (Hile, 1936). It is possible that at approximately 6 to 8 inches in total length or at 4 years of age the larger trout may migrate downstream to replenish fishing waters, and the breeder stream may thus function as has been assumed.

CONCLUSIONS

The outstanding argument used by laymen in recommending the closure of small streams as trout breeder waters is that the water temperature remains low during the summer. The lower the water temperature, the better the stream. This is obviously a fallacy. The so-called fingerling trout observed in many streams may be three or four years old.

The following points should also be noted in establishing trout breeder streams:

1. In northern streams brook trout do not necessarily migrate into smaller

streams for spawning but often spawn in larger streams where bottom and temperatures are suitable.

2. The trout population of a breeder stream may constitute a resident population.

3. Four-year-old trout (those having scales with 3 annuli) are found inhabiting the headwaters of breeder streams in association with 0, 1, and 2 groups.

4. The downstream migration of brook trout, if it exists, is not determined by age but probably by size attained, and might be considered a reaction against the limited space and water area of headwater streams.

5. The above data apply only to cold northern trout breeder streams with short growing seasons and low summer water temperatures, and probably are not of value in considering southern streams where summer water temperatures often reach the seventies, Fahrenheit.

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A CENSUS OF RED FOXES AND STRIPED SKUNKS IN CLAY AND BOONE COUNTIES, IOWA[1]

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The movement to manage wildlife has amplified the importance of developing and perfecting techniques for obtaining accurate data about animal populations. Especially needed are techniques for determining populations of fur-bearing animals.

The data presented in this paper are concerned with a census of the red foxes (*Vulpes regalis*) and striped skunks (*Mephitis m. avia*) in Boone and Clay counties, Iowa. The investigation, requiring approximately 500 man-hours, was undertaken and completed within the months of May and June, 1938.

Little consideration was given to direct observation as a means of enumerating either the red foxes or the striped skunks. The localized "sign" of an activity involving an estimable number of individuals appeared more suitable to counting; hence, an inspection of the rearing dens of red fox and striped skunk families was undertaken. In order to obtain representative data on an adequate scale, a sampling method was necessary. Section (640 acres) units were recognized as desirable samples, especially since they were well-marked by roads and line fences. The samples were located in geometric symmetry by a "checkerboard" selection in which two sections were left unexamined between those examined. In all, 128 samples, 64 to each county, were thoroughly inspected for dens.

Inspection was planned so as to maintain high efficiency without too heavy drafts upon the time and energies of the observers. The sample sections were inspected by tiers, and each was studied as represented on an up-to-date map of the county before the inspection was begun. The map revealed the relationship of the section to roads, railways, and towns. The section was then visited, preliminary reconnaissance made by automobile, and a plan for inspection formulated. Where sections were bounded by roads on only one or two sides it was necessary to identify line fences before inspection could be made. The amount of land that could be effectively observed from any one point along the line of movement depended on the range of vision, and the latter in turn was governed by the topography and vegetation. On comparatively level land the observers followed the direction of the fence rows, but on heavily eroded land contour lines were followed to reduce walking effort. The inspectors worked abreast except on areas that could be handled by one or two traverses. A railroad right-of-way, for example, could be inspected by one observer; thus the remaining observer was free to move the automobile. All land in hay, pas-

[1] Journal Paper No. J-582 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project Nos. 549 and 598. Iowa State College, Iowa State Conservation Commission, and American Wildlife Institute cooperating with the U. S. Bureau of Biological Survey.

ture, or woods; banks of drainage ditches; waste land; fence rows; and railroad right-of-ways were thoroughly inspected. Crop land in small grain was examined from some vantage point, and when necessary a powerful field glass was used. As these crop lands were marginal in utility to denning animals and as the vegetation was not yet dense, this inspection proved satisfactory. Intertilled crops such as corn and soybeans were only superficially examined.

As the investigators passed over the land such leading evidence of potential denning populations as tracks, odors, scats, pathways, and signs of predation were occasionally found. Information gained through talks with people met in the fields proved both helpful and the reverse; the good will resulting from these contacts, however, appeared to justify them. When a den was located all of the "sign" was carefully considered. Red fox dens were usually well-marked by pathways, remains of prey, scats, odor, and other "foxy" evidence. As the season progressed the foxes began to move, and decision as to whether a given den or series of dens was in active use was sometimes reserved until additional visits were made. Striped skunk dens were usually identifiable by nest material found in the runway. Other evidence such as scats, tracks, skunk hairs, and odor proved helpful. Nearly all final determinations as to the status of dens were made after examination by both of the writers.

Cards on which to record significant data were prepared. A card (Fig. 1) record was made of each section inspected regardless of whether active dens were found.

Section Card

County: _____ Date: _____
Township: _____ Section number: _____
Farmsteads: _____
Schools: _____ Churches: _____ Cemeteries: _____ R.R.: _____
Annual cropped land: _____
Other land: _____
_____
Topography: _____ Water: _____
Fence rows: _____
Desirability as a den site: _____

Figure 1

All land use was indicated on these cards by estimated acreage. This information provided a perspective for analyses of the factors limiting populations. Detailed notes were taken on each active rearing den located, and in order to preserve uniformity, card forms (Fig. 2) were also used for recording this information. The den ecology record was made primarily to preserve the data for further treatment; however, it served also to build the perspective needed in analyzing the influences affecting the populations.

AREAS INSPECTED

Interest in the relation of red foxes to game birds prompted the selection

of Clay County in ring-necked pheasant (*Phasianus colchicus torquatus*) range. Boone County, representing a marginal zone for pheasant and bob-white (*Colinus v. virginianus*) range, was chosen to serve as a check area. Clay County is in the northwestern part of Iowa, one tier of counties south of Minnesota and two east of South Dakota. Boone County is immediately west of the geographic center of the state. Both counties lie within the limits of the Wisconsin drift sheet of pleistocene age. Both are square and are approximately equal in size, each containing 576 sections. By survey error, Boone County is about one per cent larger than Clay County; it comprises 3,840 acres.

Den Ecology Record

Species: _____

County: _____ Date: _____

Township: _____ Section number: _____ Den number: _____

		Exposure	Dimension	Direction	Slope (outside)
Den openings:	a.				
	b.				
	c.				

Nearness of farmstead: _____, roadway: _____, fencerow: _____

Origin of den: _____ Population of den: _____

Water: _____, form: _____ nearness: _____ Soil: _____

Food items: _____ Scat numbers: _____

Plant environment: _____

_____

Remarks: _____

Figure 2

In Boone County the continuity of the topography, which for the most part is level or gently undulating, is broken by a series of morainic hills along the north border in the eastern half of the county, and also by the Des Moines River Valley. The latter is a deep gorge through the center of the county from north to south with steep and severely eroded slopes, extending from one to three miles into the prairie. The upland in Clay County is flat or gently undulating. The relief becomes more rolling in the southern part of the county and strongly so along the Little Sioux River. There are a few morainic hills in the east near the poorly drained lake region.

POPULATIONS

The counties censused contained many areas such as lakes, rivers, flood plains, marshes, and certain cropped lands unavailable for dens. As the calculations for this census include these blanks, the population figures obtained are considered representative.

The data at hand indicate that there were from two to nine red foxes to the litter. Observation showed, however, that the average productivity to the family was four. This figure represents the average number of young last seen at rearing dens. As Seton (*Lives of Game Animals*, 1929) and others consider the red fox monogamous, a population of two adults and four young

was attributed to each family. It was certain that an unknown percentage of adults was unmated, never came in heat or failed to become pregnant. Though no data were available, it was assumed that two-thirds of the adults produced young. In order to include the unproductive animals, one adult was added to the quota for each family. Thus, seven was considered to cover both adults and young that should be reckoned in the census for each family identified by occupation of rearing dens.

A bounty on foxes was being paid in both counties investigated, and a number of dens were dug into by farmers and sportsmen. Of the eight active dens found on 128 sections, only one had been successfully excavated. As in practice only the young are taken, this indicated a loss of four, 7.14 percent, from a total population of 56 (the family population, 7, times the number of families identified by occupation of rearing dens, 8).

The total population was calculated as follows: N is the number of families found by examination of rearing dens on the sample units of each area censused. The population to the family is p, and the total population P. The conversion factor, F, is obtained from a division of the total number of sections by the number inspected, in this case 576/64 or 9. The percental loss of production through excavation of dens is L. The total population is then determined by use of the following formula:

$$(NpF)-[(NpF)L]=P.$$

The rearing dens found on the 64 sections inspected in Boone County evidenced 6 red fox families. The total population for the county was then calculated:

$$(6\times7\times9)-[(6\times7\times9).0714]=351.011$$

or one animal to 1.64 sections of land. In Clay County where only two families were found on the sample area the following total population is indicated:

$$(2\times7\times9)-[(2\times7\times9).0714]=117.004$$

or one animal to 4.92 sections of land.

Figures on bounties paid for foxes in various counties would indicate somewhat higher populations. In part this was because a large number of the bounties were paid on young foxes from dens, the number of which would be reduced later by natural causes. In addition animals may have been presented for bounty in paying counties even though they were taken elsewhere.

For the striped skunk seven appeared to be the best number to use for the family population index covering two adults and five young. Assigning five young to a family was based on field observations of half grown skunks (Selko, unpublished notes). Seton recorded the average number of young to be four for yearling females and six for older females in captivity. Although this skunk is considered polygamous, two adults were assigned to each family in order to account for a proportion of unmated individuals. Much more must be learned about the reproductive cycle and productivity before better computations can be made. It was illegal to take skunks out of season or to dig them out at any time and no losses were apparent from either of these causes.

The formula used for calculation of the striped skunk population was:

$$NpF=P.$$

TABLE 1

PRINCIPAL LAND USES IN CLAY AND BOONE COUNTIES, IOWA[2]

Land Use[3]	Boone County	Clay County	Den Site Classification
Corn	136,586	127,759	Inadequate
Oats	79,145	79,770	
Barley	1,243	11,659	Marginal
Total	80,388	91,429	
All Clover and Timothy	5,291	4,433	
Alfalfa	8,823	12,085	
Wild Hay	2,090	3,689	Adequate
All other Tame Hay	2,140	2,828	
Pasture	73,836	71,528	
Total	92,700	94,563	

In Boone County the rearing dens indicated 37 striped skunk families on the 64 sections surveyed, and the total population for the county was estimated as:

$$37 \times 7 \times 9 = 2{,}331 \text{ or}$$

4.04 animals to a section. The highest local population density in Boone County was indicated by eight families on a half section.

In Clay County 15 striped skunk families were located on the sample areas, indicating the following total population:

$$15 \times 7 \times 9 = 945 \text{ or}$$

1.64 striped skunks to the section. The highest concentration found in Clay County was six families on one section.

[2] Data obtained from the Iowa Year Book of Agriculture, 1936, Iowa State Department of Agriculture, Des Moines, Iowa.

[3] Crops totaling under 1,000 acres are not included in this table.

FACTORS AFFECTING POPULATIONS

Land use was important in relation to populations of red foxes and striped skunks. About 94 percent of the land in each of the counties surveyed was grazed or cultivated; the remainder was occupied by buildings and roadways or was waste. Crop, pasture, and waste land provided all of the den sites. In the order of their suitability for use by denning foxes and skunks these areas may be termed adequate, inadequate, or marginal. Land devoted to an intertilled crop such as corn was inadequate. Fields of small grain occasionally harbored dens, but appeared to be second choice. Possibly this was because there was little or no growth in them at denning time or because all of the old dens had been plowed under. Such crop land was considered marginal. Hay and pasture land provided the most suitable den sites, and were classed as adequate.

TABLE 2

TOTAL ACREAGE BY COUNTIES OF DIFFERENT SLOPE CLASSES[4]

	Bottom Land	Upland 0–3%	0–5%	0–5% with some 5–10%	5–10%	5–10% with some 10–15%
Boone	0	37,760	211,200	30,720	15,360	0
Clay	64,000	69,760	188,800	4,480	0	0

	5–10% with some 10–15% and some over 15%	10–15% with some 5–10%	10–15%	10–15% with some 5–10% and some over 15%	Total Acreage
Boone	0	0	0	69,120	364,160
Clay	0	33,280	0	0	360,320

Table 1 gives the latest (1936) available data on the acreages involved in the principal land uses in Clay and Boone Counties. Although more recent data had not been compiled, it was evident that any differences in 1938, when the present survey was made, were insignificant. As the total acreages considered adequate for the denning animals were about the same, it would be expected that the fox and skunk populations of the two counties would be similar.

Inspection having shown that they were quite different, search was made for the cause and it appeared that topography was the principal variable responsible for the differences in the populations of the two areas. Red foxes and striped skunks prefer dry, well-drained homes, and most of their dens were found where the slopes were from 5 to 10 percent or more. One red fox den and four striped skunk dens were found in land that was predominantly under five percent slope; even these

[4] Walker, R. H. and P. E. Brown. Soil Erosion in Iowa, Special Report No. 2, Agricultural Experiment Station and Soil Conservation Service. April, 1938; Ames, Iowa.

TABLE 3

SLOPE-POPULATION RATIOS BY COUNTY

	Acreage and Population		Ratios	
	Clay	Boone	Clay	Boone
Acreage of Slope predominantly 5–10% or over	37,760	115,200	1.00	3.05
Number of Red Fox Dens	2	6	1.00	3.00
Number of Striped Skunk Dens	15	37	1.00	2.43

dens, however, were found in small mounds with slopes of three to seven percent. Thus, the data indicated that the area satisfactory as denning sites to these species could be mapped by slope class.

Available data summarized in Tables 2 and 3 demonstrate a significant correlation of population with slope. Possibly slope classes may be used as indices to relative populations of these fur-bearers on other areas, providing similarity in other variables prevails.

The effect of a water supply on the red fox and striped skunk populations was considered, but the data did not indicate an obvious effect for the area as a whole. Possibly this was because water was almost always available at a near-by farmstead. All of the red fox dens and the heaviest population densities of striped skunks, however, were found within one-third mile of streams, and in general more wildlife was observed on sections having a natural supply of water. It was especially gratifying to note local concentrations of wildlife about soil erosion check dams constructed by the C.C.C. in Boone County.

The attitude of human neighbors appeared to limit the populations of these fur-bearers locally. Apparently satisfactory den sites were found unoccupied in localities where the sentiment was decidedly anti-fox or anti-skunk, but dens were frequent where people were indifferent or active in protecting these mammals. Possibly more recreation and satisfactory control of the red fox population could be obtained from increased hunting in season, rather than by the sporadic and ineffective den excavation previously mentioned.

With respect to some sections that appeared suitable for denning activity, but were found to be uninhabited, the most plausible explanation seemed to be the repressive effect of dogs hunting over the areas.

CONCLUSIONS

The census technique here described may be adapted to advantage by the game technician, as the detailed inspection of land gives an excellent opportunity of becoming acquainted with wildlife and its relationship to land use. That the method will not be entirely satisfactory until more is known concerning fur animal reproduction and the factors affecting populations is granted. Uses of the technique in its present form, however, will tend to establish standards from which to evaluate the data annually assembled. Such information gathered and appraised under State administration would be far better than the guesses as to populations that have prevailed and would facilitate real management of the upland fur-bearer resource.

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FALL AND WINTER FOOD HABITS OF VERMONT BOBCATS

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The bobcat (*Lynx r. rufus*) has a wide distribution in Vermont. Bounty claims indicate that the animal is well represented in the sparsely wooded farm sections of the southern part of the state as well as in the rugged forested slopes of the Green Mountains. Because of its supposed destruction to game species, a bounty has been maintained on the wildcat for a number of years. From 1927 to 1937 inclusive, bounties were paid on 2,415 bobcats, at an expense to the state of $20,095. During the years 1927 and 1928 an $8 bounty was paid; from 1929 to 1932 the bounty was increased to $10. This apparently focused attention on the profit to be derived from bobcat hunting and the numbers taken increased yearly until 1932, when 550 animals were offered for bounty. In 1933 the bounty was reduced to $5. This change was reflected in a marked decrease in the number of bounty claims, there being but 82 in 1933. The number of bounty claims has been increasing steadily, however, since then and has now risen to 160.

Since little was known of the dietary habits of the bobcat in the northeast, it seemed desirable to gather such data as the opportunity afforded. Accordingly, in the fall of 1935, Hunter began collecting stomachs, taking weights and measurements, and enlisting the aid of game wardens in securing bobcats. Specimens were collected through succeeding years until April 1938. The stomachs were shipped to Hamilton, who examined them. A total of 143 animals were studied. Of this number, 2 were collected in October, 25 in November, 63 in December, 26 in January, 16 in February, 9 in March and 4 in April. Three stomachs were quite empty, leaving 140 specimens satisfactory for analysis.

A brief review of the status of game animals on which the bobcat feeds may aid understanding of the findings. During the past five years, both hare and rabbit populations have been low, but are making slight gains and grouse have been fairly common. Deer were practically exterminated in Vermont in 1870. A few were introduced later and after a period of protection, their hunting was permitted. In 1937, 2,446 deer were killed; the average for the past ten years has been 1,824.

In examining the stomachs, it was usually noted that a single item of food was represented. Many exceptions to this were recorded, however, some of the most interesting being given below. A 12-pound bobcat shot in the city of Bennington, on December 9, had eaten a gray squirrel, flying squirrel, and deer mouse. A 23-pound specimen taken at Coventry on December 26, had red squirrel, mink, muskrat, and fish remains in its stomach. A 32-pound animal, killed by a car on November 4 at Royalton, had last eaten a single chipmunk, red squirrel, and deer mouse, three field mice, and a small unidentified bird.

DISCUSSION OF FOOD ITEMS

Deer. Hair and flesh of deer were evident in 22.9 per cent of the stomachs. In several only a few hairs were found, while others were greatly distended with deer flesh. The stomach of a 19-pound cat contained 895 grams (nearly two pounds) of deer flesh and hair. We do not know what proportion of the deer eaten was carrion. During the open season on deer, many are fatally shot but not recovered by hunters. These might conceivably provide a major share of the deer meat that is eaten by bobcats. Several of the animals whose stomachs were well filled with deer meat did not exceed 9 pounds in weight; it is incredible that such a small bobcat could subdue a deer in good health. On the other hand, there is considerable evidence that adult bobcats are capable of killing deer. A bobcat attacked a yearling Colorado deer, hung on and floundered through the snow with it for a distance of fifty feet before the deer went down. After eating part of the hind quarters, the cat completely covered the carcass with snow, except for the head (Young, 1928). Grinnell, Dixon and Linsdale (1937) present evidence that the California bobcat kills deer upon occasion, and Newsom (1930) records two Maine deer being killed in a few minutes by a bobcat. We can well believe that some of the cats examined for this study, that weighed from 30 to 36 pounds, would have little difficulty in tearing the throat of a deer, especially if it were overtaken in deep snow.

TABLE 1

FREQUENCY OF OCCURRENCE AND BULK PERCENTAGE OF FOOD ITEMS IN 140 BOBCATS TAKEN IN VERMONT FROM FALL TO LATE WINTER, 1935–1938

Food	Frequency of Occurrence	Percentage by Bulk
Deer[1]	32	19.32
Mice	35	18.57
Hares and rabbits	31	16.43
Porcupine	12	7.07
Squirrels	13	6.46
Grouse	12	5.50
Skunk	7	4.36
Shrews	5	2.46
Muskrat	5	2.36
Carrion	3	2.01
Bluejay	4	1.00
Red Fox	1	.82
Gray Fox	1	.70
Poultry	1	.65
Green grasses	3	.43
Fish	1	.28
Mink	1	.21
Insects	1	.21
Extraneous	17	11.16

[1] Some deer meat probably taken as carrion.

Mice. Exactly 25 per cent of the bobcats which we studied had eaten mice. Field mice (*Microtus*) were represented in 18 stomachs, deer mice (*Peromyscus*) in 13, red-backed mice (*Clethrionomys*) in 3, and the pine mouse (*Pitymys*) and lemming mouse (*Synaptomys*) in one each. It appears that wildcats may spend considerable time hunting mice. Several stomachs contained two or three field mice, and one cat had eaten 5 of these voles. After being bitten in several places, the mice are usually bolted entire.

Hare and Rabbit. Of the 31 cats which had eaten leporids, 23 contained remains of the varying hare (*Lepus*) and 8 those of cottontails. Other investigators have stressed the importance of these lagomorphs to the bobcat, and Seton (1929) has a long discussion of the dependence of the lynx on the snowshoe rabbit.

Porcupine. Represented in 12 stom-

achs (8.6 per cent of the animals examined), the porcupine appears to be an important food species of the bobcat. The cats which had eaten porcupines weighed from 7 to 19 pounds—not fully mature animals. In most instances they had suffered no visible effects from the encounter with this prickly prey, but one record suggests that the cat may pay with its life for a meal of porcupine flesh. Mr. Stygles of Jericho, Vermont, killed a bobcat in his dooryard on April 21, 1937, that was in a hopelessly weakened condition, its head and forequarters filled with porcupine quills. A 9-pound cat was stuck up badly, the mouth, lips, walls of stomach, duodenum, and omentum all had numerous quills, while many were working through the walls of the thorax. Another small cat had numerous softened quills in the muscles of the hind leg and abdominal wall, while numerous fresh quills were imbedded in the neck. The stomach contained a quantity of quills, fur and flesh. In these cases the porcupine quills did not seem to affect the cats adversely, even when working outward from the intestine. Parts of porcupines are occasionally utilized for bait by wildcat trappers, but we possess positive evidence that a number of these animals whose stomachs contained porcupine remains had been shot. Dearborn (1932) found merely a trace of porcupine in the droppings of 300 Michigan bobcats.

Squirrels. Squirrels had been taken by 9.3 per cent of the cats: gray squirrels six times, red squirrels five times, and flying squirrels and chipmunks each twice. The entire remains of a gray squirrel removed from the stomach of a 20-pound cat weighed 21 ounces. Usually the limbs appear to be torn from a squirrel, and the carcass then bitten into two or three pieces. Four of the gray squirrels had been caught during the late fall of 1935, when these rodents were unusually numerous in New England. Several stomachs contained the remains of more than one squirrel.

Grouse. Twelve bobcats had eaten grouse, and in almost every instance the feet, in a good state of preservation, were recovered from the stomach, together with an occasional bill, and feathers and flesh. It is evident the bobcat has little trouble in catching grouse, although Dearborn (*loc. cit.*) found "no evidence of grouse remains in more than 300 feces, although grouse were abundant around the swamps where the wildcats live."

Skunk. Of the bobcats examined, 5 per cent had eaten skunks. All the cats which had eaten skunks were taken during the open season for this furbearer, so it is not improbable that trapped skunks were, at least in some instances, the victims. Dearborn (*loc. cit.*) notes a trace of skunk in the droppings of wild cats, and Barton (1878) records a skunk having been eaten by a lynx.

Shrews. Five bobcats had eaten shrews, the stomachs all containing the ubiquitous Blarina except one, that held the little masked shrew, *Sorex cinereus.* This tiny mammal weighs scarcely more than a penny, and was the only food in the stomach of a 10-pound wildcat. House cats have little taste for shrews. Although many are caught, they are usually discarded. Their wild cousins seem not averse to

these abundant little creatures, and eat them as opportunity affords.

Muskrat. The stomachs of five bobcats contained muskrat remains. All of these cats were taken during the trapping season for muskrat, so it is possible in some instances, that the cats had come upon trapped animals.

Carrion. Flesh from the rhinarium, hair, and skin of cattle were found in 3 stomachs. This possibly represents offal from fall butchering. Carrion undoubtedly plays a more important part in the dietary of Vermont wildcats than is here indicated. It seems more than likely that a good share of the deer remains in the stomachs represents animals that were found in the woods, dead from shooting or natural causes which the rigorous northern winter promotes.

Blue Jay. Remains of this bird were taken from 2.8 per cent of the stomachs. It is useless to conjecture how these birds were caught but the observations of Grinnell *et al.* (*loc. cit.* p. 620) are suggestive. They state that wildcats when hunting in the daytime are often discovered by jays, which "mob" them and thus warn other animals of their approach. When the cats are thus mobbed, they hide until the birds quiet down. Possibly an incautious jay, in a frenzy of excitement, occasionally comes within reach of a lightning stroke of the cat's paw. Red foxes are adept at catching blue Jays, the remains of these birds often being found in the stomachs or about the dens (Hamilton 1935).

Foxes. A 30-pound bobcat taken at Glover, Vermont on February 28, 1938, had a quantity of fur, and toes and flesh of a red fox in its stomach. The stomach of a 21½-pound cat, shot at Brighton, Vermont on April 4, 1938, contained a mass of flesh and fur of a gray fox. We know of no previous record of bobcats preying on foxes, but Seton (*loc. cit.*) gives much testimony that the Canada lynx kills the red fox.

Miscellaneous Food Items. The feathers of a white leghorn chicken were taken from one stomach. It is possible this represents carrion, as many farmers throw out dead fowls with manure during the winter months, and foxes, skunks, and crows are known to feed on the dead poultry. Green grasses were found in three stomachs in sufficient quantity to preclude the possibility of accidental ingestion. Several fragments of the vertebrae of a large fish were found in another stomach. They appear to match samples from the common white sucker.

Sizeable fragments of a mink skull, together with its feet, tail, and much flesh were found in a bobcat shot in December. In the same stomach were parts of the tail and some fur of a muskrat. The mink is known to be a mortal enemy of the muskrat, killing large numbers during the winter. It seems possible that this mink may have been feeding on the carcass of a muskrat when surprised and killed by the bobcat. One wildcat had eaten nothing other than the big cocoon of a Polyphemus moth.

Many of the stomachs contained small green twigs and bark. As most of these were of trapped animals, it seems likely that this woody debris had been chewed from the trap stake or from brush within reach. Some of the animals that had been shot, however, contained similar debris, together with bits of flesh and deer hairs, which suggests

they may have taken some of the paunch contents of the deer.

More than half of the stomachs had heavy infestations of roundworms (*Physaloptera* sp.).

SUMMARY

Stomachs of 140 bobcats taken in Vermont from fall to late winter over a three-year period were analyzed. The results indicate that the chief food of the bobcat consists of deer (probably much of it carrion), mice, chiefly *Microtus* and *Peromyscus*, varying hares and cottontails, porcupines, squirrels, and grouse. Shrews, muskrats, carrion, and blue Jays, were eaten less frequently. Such items as red and gray foxes, grass, poultry, fish, mink, and insects also are included in the winter dietary of the bobcat. Because we know practically nothing of the ecologic relationship that exists between the bobcat and its prey, much of which is game, we draw no conclusions. It does seem significant, however, that in spite of the abundance of the bobcat, the general population level of all wild game remains satisfactory except as it is affected by man, epizootics, or adverse climatic conditions.

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THE PROBLEM OF WILDLIFE DESTRUCTION BY AUTOMOBILE TRAFFIC

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Within recent years numerous articles on the destruction of wildlife on the highways have appeared in both technical and nontechnical magazines. Most of the records have resulted from observations during a single vacation trip or in a restricted locality. Thus they are subject to a large element of error in sampling.

The accounts usually mention the species and numbers of victims, the localities where observations were made, and the mileages traveled. In some instances all species are recorded. In others observations are limited to mammals and no attempt is made to record other animals. Thus there is accumulating a volume of statistical data which still remain to be interpreted carefully but which may eventually lead to information of great value to conservationists. The following statistics and comments are offered as an approach to solution of the problem and to the derivation of values apparently not usually envisioned.

Data and Methods

The statistics and observations here presented were collected by the writer over a period of about three years during which he covered more than 75,000 miles by automobile in the States of Virginia, Tennessee, Georgia, Florida, Alabama, Mississippi, Arkansas, Missouri, Illinois, Oklahoma, Texas, New Mexico, Arizona, and California. It was not possible to keep records on all of this travel but a total of 62 travel-days are involved having a representation of at least three days in every month except August and September. Data for these two months in 1936 and those for the entire year, 1934, were lost when a notebook was stolen from a parked automobile. The loss of these records is regretted particularly because they covered several hundred miles of travel in a distinct ecological province—the delta country of Mississippi.

These statistical data are summarized in Table 1; the graphs in Figures 1 and 2 are based chiefly upon this table. In Table 2 the data have been segregated by types of roadside environment. In the graphic presentation (Figs. 1–4) published data have been included as noted.

No attempt was made to record dead animals on all trips. Frequently it was necessary to travel over congested highways and under weather conditions such that the entire attention of the driver was needed to avoid adding one or more members of the genus *Homo* to the list of casualties. To reduce the effect of subjective selection in the records, counts were made: (1) Whenever conditions permitted travel at a rate enabling the driver to slow down occasionally and tally a previously prepared sheet of paper or to take notes, which were summarized at the end of the day; (2) whenever the task of driving could be foisted upon some other technician, leaving the writer free to make observations and take notes at will; and (3)

whenever a traveling companion could be induced to record notes as dictated.

Let me acknowledge at this point my obligation to fellow technicians of the National Park Service who have served as both secretary and chauffeur, and to my wife who has kept the records during several journeys to new headquarters and on vacation trips. I am indebted also to the librarian of Leland Stanford Junior University for the privilege of using the reference library of that institution, and to Victor H. Cahalane of the Wildlife Division, National Park Service, and Dr. Orland E. White of the Blandy Experimental Farm, University of Virginia, for reference material.

TABLE 1

Month	Miles	Armadillo	Birds (song)	Cat	Dog	Fowl	Frog	Hawks and Crows	Mice	Opossum	Porcupine	Quail	Rabbit, Cottontail	Rabbit, Jack	Rat	Road Runner	Skunks	Snakes	Squirrels	Terrapins and Turtles	Toads	Turkey	Unidentified	Woodchuck	Totals	No. victims per mile	No. days traveled	No. victims per day	Average No. miles per day
January	1,063		1	5	5								10	1											22	.0206	4	5.5	265.75
February	1,797			15	7	11				2			45	1			3								84	.0467	10	8.4	179.70
March	226			2									2												4	.0177	3	1.3	75.33
April	914			1		1				1			16												19	.0207	7	2.7	130.57
May	682	6		6		2						1	12	40				5		2			1		75	.1099	5	15.0	136.40
June	1,406		18	6	3	6				3			10				2	2		6	10		2		68	.0484	4	17.0	351.50
July	962		6	3	4	4	1						17	4			1	3	1	2	10			2	58	.0603	5	11.6	192.40
August																													
September																													
October	1,455		76	5	5	4		3	2		1		97	103	45	1	11	4	10						367	.0252	6	61.1	242.50
November	1,534			2	1	1							11					3							18	.0117	9	2.0	170.44
December	2,189	1	5	14	2	6		1					59	10			2					4			104	.0475	9	10.4	243.22
TOTALS:	12,228	7	106	59	27	35	1	4	2	6	1	1	279	159	45	1	19	17	11	10	20	4	3	2	819	.0670	62	13.2	197.22

In one respect the subjective factor of personal judgment has been deliberately introduced, namely, in restricting records to those of animals that had apparently been killed during the twenty-four hour period immediately preceding the observation. It is believed that this has been accomplished with a minimum of error. In all of the area traversed, except parts of the Southwest, the turkey vulture (*Cathartes aura septentrionalis*) or black vulture (*Catharista urubu*) or both, are common, and regularly feed on dead animals along the roadside. If occasionally we have made underestimates of the time elapsed between death and observation, they are probably more than balanced by removal of specimens by these and other scavengers immediately after death. In the Southwest one can be less certain of one's judgment, but here the arid atmosphere tends to desiccate animal remains and after twenty-four hours—which would include one period of several hours' exposure to sunlight—the carcass of a small animal begins to assume a semi-mummified condition if, in the meantime, it has not been pancaked by the passage over it of many wheels.

DISCUSSION

A complete analysis of wildlife destruction by automobiles is at present impossible; but there is at hand a

TABLE 2

Roadside Environment	Miles	Armadillo	Birds (song)	Cat	Dog	Fowl	Frog	Hawks and Crows	Mice	Opossum	Porcupine	Quail	Rabbit, Cottontail	Rabbit, Jack	Rat	Road Runner	Skunks	Snakes	Squirrels	Terrapins and Turtles	Toads	Turkey	Unidentified	Woodchuck	Totals
Piedmont and Coastal Plain type	3,955		16	15	9	3				3			35				2	3	1	1	13		1		102
Wooded Plateau type	1,893		6	5	2	4				1			26				1			1	3		1		50
Western Plain type	6,380	7	84	39	16	28	1	4	2	2	1	1	218	159	45	1	16	14	10	8	4	4	1	2	667
GRAND TOTALS:	12,228	7	106	59	27	35	1	4	2	6	1	1	279	159	45	1	19	17	11	10	20	4	3	2	819

growing body of statistical data on the rate of destruction of wildlife on the highways. As Linsdale (5) has pointed out, these data touch only one phase of a complex series of relationships. He concludes that the benefits to songbirds attendant upon road construction outweigh the destruction through automobile killings. Linsdale is considering resident, breeding populations, however, and presumably under California conditions. The same conclusions do not necessarily apply to situations where migrating flocks of birds become con-

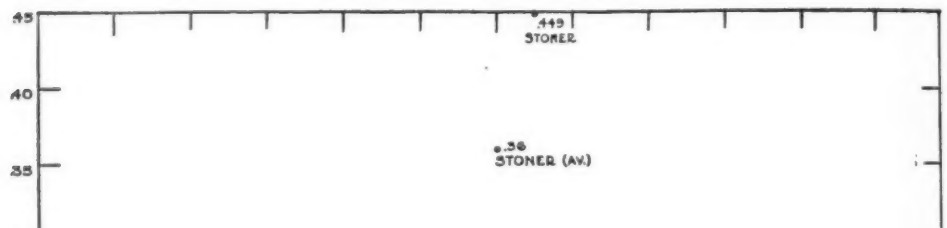

Fig. 1. Graphic summary of the numerical data presented in Table 1.

centrated along a highway, the margins of which afford the most attractive or even the only cover and food available in an overgrazed plains country. Leopold (4) has concluded—and logically supports his conclusions—that from the standpoint of game management, highway losses are unimportant except where peculiar and specific conditions such as the application of mineral salts to highways, as a dust preventive, result in unusual concentrations of animals in heavy automobile traffic. These conclusions do not mean—nor do the statements of the authors imply—that adequate data and the study of wildlife destruction by automobiles will not yield valuable information on the behavior of native wildlife and aid in the development of sound conservation practices. Rather, they emphasize the warning voiced by Dreyer (2) that no sweeping conclusions should be drawn regarding the destructiveness of the automobile until more nearly complete and comprehensive data are available.

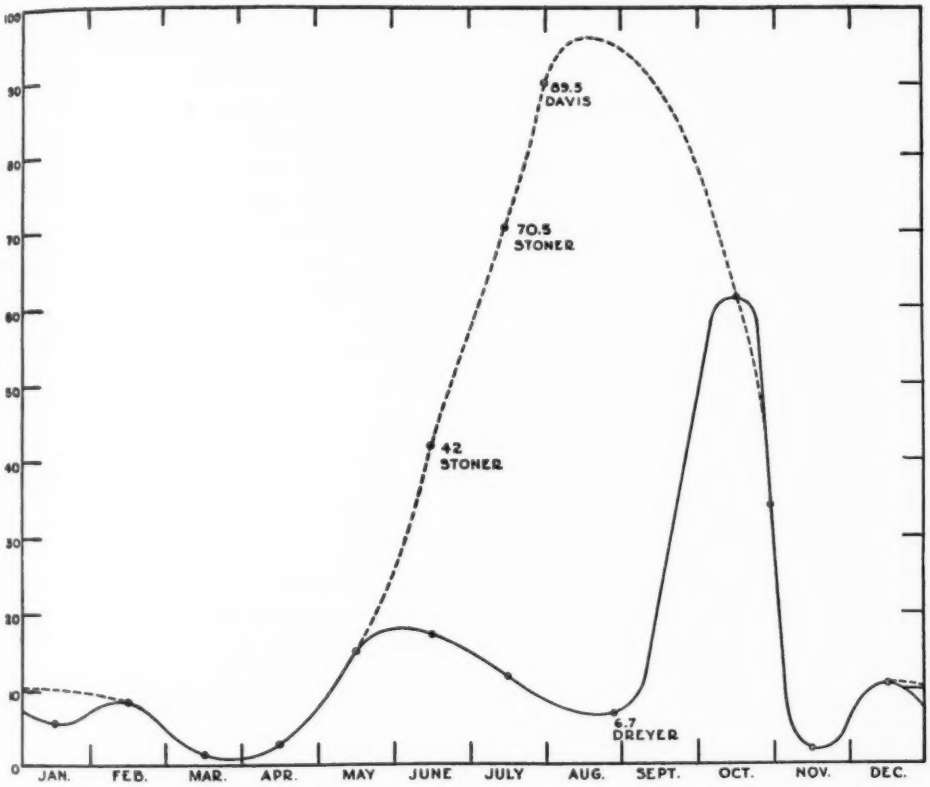

Fig. 2. A graphic presentation of available data on per-day rate of destruction. The dotted line represents a purely theoretical distribution which, however, coincides closely with certain published data. The solid line represents the writer's notes completed through the months of July and August by the use of Dreyer's published data.

With these viewpoints the writer is in full accord. Instead of fruitless speculations and sweeping conclusions, the present need is for the accumulation of field data and for such experiment as may be practicable.

the relative density of animal populations in adjacent areas. In no case is there adequate information at hand on this point, and it can be obtained only through censuses of both resident populations and of the animals destroyed

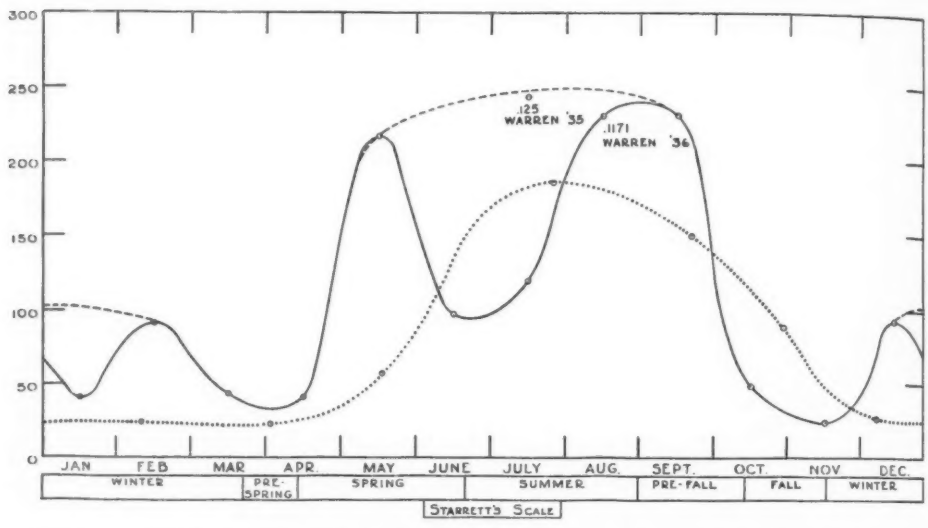

Fig. 3. A graphic presentation of the writer's data by ten-day periods of travel at average per-day rate of destruction and average daily mileage derived from Table 1. To this has been added the observations of other writers computed on a comparable basis. The broken line (dashes) represents a theoretical probable distribution for the period concerned.

The dotted line is a graph of observations on a given environment through an entire year as published by Starrett. The points on this curve are computed on the same basis as those in the other graph shown; but the totals are reduced to one-third their gross value to bring them in scale with the writer's presentation.

The statistical data available lack both satisfactory volume and continuity, defects that can be remedied in time. The most serious fault is the lack of adequate descriptive field data. Gordon (3) limited his observations to roads bordered by sage brush. Most reporters have, however, left the matter of roadside cover conditions entirely to conjecture.

Another important factor in the destruction of animals on the highways is

in comparable, or preferably in the same, environment. This will require continued observation on a given area and if supplemented by studies of experimentally modified roadside cover, may prepare the way for reduction in wildlife mortality rates through modification of roadside environment. In connection with this suggestion, attention is called to the results summarized in Table 2 and Figure 4. The western plain type of road shows a per-mile

rate of destruction (.1045) about forty times as great as either the piedmont and coastal plain (.02557) or the wooded plateau type (.0264) of roadside environment. Further study may reveal the desirability of more discriminating classifications of roadsides. The marked difference here noted is probably due in part to the greater density of the cottontail population in the plains country traversed. Such observations as the writer has been able to make indicate, however, that land-use practices in the plains type of country tend to concentrate cottontail populations along the highways more than do those prevailing in the other types of environments considered.

Certain other circumstances modify traffic hazards for wildlife:

1. Animals may be destroyed on highways under conditions that make the automobile a secondary rather than the primary factor. An illustrative instance was observed between Tucumcari and Albuquerque, New Mexico, where 75 kangaroo rats were counted in a mile as measured by the speedometer of the car. These animals had been trapped in bituminous road oil which had been spread late in the evening. Only those animals actually on the highway surface were counted. Careful examination at several points disclosed numerous animals which had freed themselves from the sticky surface only to die later with all of their feet glued to the body fur.

2. The distance from the road to escape cover apparently is of considerable importance. For observations on this point the center of the highway and the drainage ditches were selected as arbitrary reference points. Of the 279 cottontail rabbits recorded by the writer only three or 0.68 per cent were observed in locations where the distance from shrubby cover to the drainage ditch was less than the distance from the drainage ditch to the center of the highway. On narrow, one-way roads, however, where shrubby cover extended up to or even overhung the traffic lane, the hazards appeared to be great. Two of the three animals referred to above were observed in such locations. Several times the writer, while following cars through such detour roads, observed rabbits and birds to burst from cover and strike cars.

3. Cars traveling at speeds above thirty-five to forty miles per hour appear to be critical hazards for both songbirds and rabbits. At speeds of thirty-five miles per hour, even such heavy fliers as flickers and other woodpeckers usually escape without difficulty. At speeds estimated at forty m.p.h. and over, they have been observed to escape less frequently unless they rise to the height of the radiator top or higher before the car approaches to within half a car length. Observation of the birds' behavior suggests that at these higher speeds the draft from the fan may be, in part, responsible for the increased hazard.

4. The blinding of small mammals in the glare of approaching headlights is undoubtedly an important factor in their destruction; particularly, in the case of rabbits. Repeated observations of cottontail rabbits suggest that the sharpness of the shadow at the margin of the light zone may be an important factor in determining the promptness, or tardiness, with which the animal

moves out of the path of an approaching car.

5. Climatic conditions may be expected to have a marked influence on the occurrence of animals on the highways. It has been observed repeatedly that fewer dead animals are encountered on mornings following rain during the latter part of the night. Also, it has been noted that more dead mammals are encountered when afternoon rains are followed by moonlit nights than when such rainy afternoons are followed by dark nights. Extremes of low temperature apparently tend to keep animals off the highways. This is not surprising because low temperatures reduce the movements of many forms of wildlife. In plains country which is overgrazed, it is not uncommon to find concentration of songbirds in highway cuts so situated that they are sheltered from severely cold winds; these birds are very likely to be killed by passing cars.

The tables and graphs presented are in large measure self-explanatory. Table 1 has been arranged to show the seasonal spread of the observations as well as the time and mileage represented. The relative acuity of the observer may be considered as a constant. No attempt has been made to give taxonomic species and subspecies. The writer has sometimes found it difficult to assign subspecies names with well-preserved or fresh specimens in hand and he does not presume to be able to do so from a moving automobile. There are probably some errors due to recording cottontails and jack rabbits separately. Young jacks may have been recorded as cottontails, in some instances, and vice versa, but this is considered to be an unimportant source of error because a large proportion of the cottontails recorded were observed in areas outside the range of jack rabbits.

Davis (1), Dreyer (2), Stoner (6), and Warren (7, 8) have reduced their observations to an animal-per-mile basis, and the writer gives his data in that form in Figure 1. This method is subject to error due to the relatively small samples and it is believed that this error is largely responsible for the extreme irregularity of the curve. A per-day rate of destruction should in a measure reduce this sort of error and still show seasonal variations. Figure 2 was prepared on that basis. Although the curve is somewhat smoothed, it is of the same general character as that in Figure 1.

Figure 3 is a graphic presentation of all available data by ten-day periods of travel at the per-day rate of destruction and average daily mileage derived from the writer's data. Warren's data (7, 8) have been used to fill in this curve for the months of August and September, when the writer's records are incomplete. The resulting graph raises more questions than it answers. The curve does show pronounced peaks, however, and demonstrates the need for both additional statistical data and adequate field notes. For instance, there is a wide discrepancy between Warren's and the writer's figures for the month of July. Stoner's (6) data reduced to equivalent terms indicate a much higher rate of destruction. Reference to the writer's field notes shows that two days of the July travel probably gave abnormally low records—one during rain so heavy and constant that no wildlife was

abroad, and the other over a detour so rough and dusty that cars were forced to travel too slowly to be a serious menace to wildlife. Warren's data were used because he mentions that both mountain and plains country are included, whereas Davis' and Stoner's data are presumably from country of low relief.

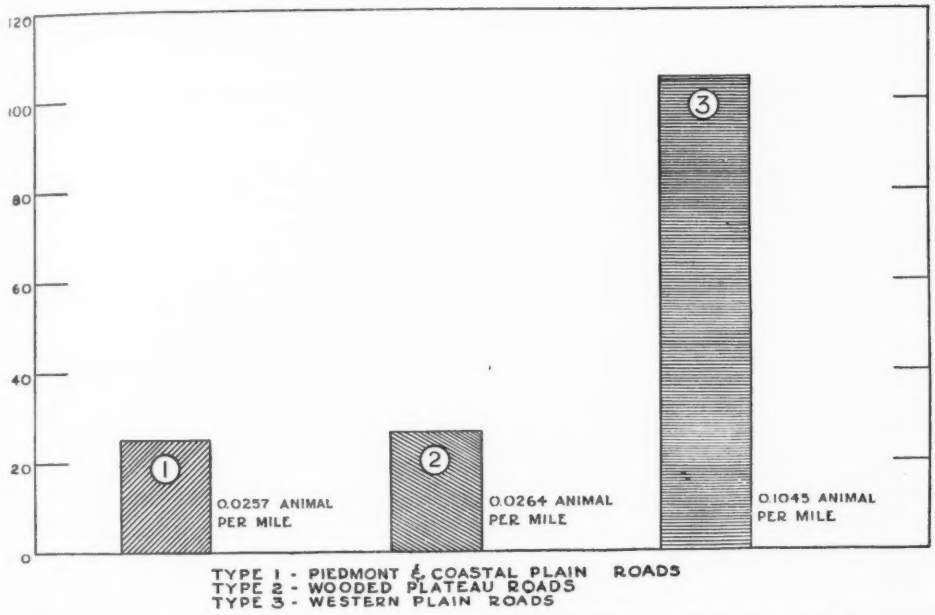

Fig. 4. A graphic presentation of the numerical data in Table 2. Note that the Piedmont and Coastal Plain and Wooded Plateau types of road are little different in destruction of wildlife while the Western Plain type shows a destruction approximately 40 times as great.

In the opinion of the writer, the most significant feature of the present discussion is shown in Table 2 and Figure 4. The plains type of environment is demonstrated to be many times more hazardous for wildlife than any of the others. If this result is confirmed, it suggests an opportunity to apply practical methods of management by modifying plains types of roadside environment toward the less hazardous kinds. Additional information may reveal that the four peaks shown in the curve in Figure 3 should in reality be reduced to two, and that there may be intergrading degrees of hazardous cover types not shown in Figure 4. On the detection and refined delineation of such relationships, the progress of intelligent wildlife management along the highway depends.

In the preparation of Figure 4, three types of roadside cover have been considered. They have been arbitrarily named according to physiographic features of the regions in which each type tends to predominate. This does not mean that the cover type is restricted to the terrain from which it is named nor that it is homogeneous. The categories are broad and each of them

contains many local areas which perhaps could be more fittingly classed in one of the others. In order to make clearer the usage of these terms, a brief description of each type as visualized by the writer is given below.

Type 1. Piedmont and Coastal Plain Roads.—In this category are included roads which are bordered by a varied vegetation in which tall grasses or broom sedges (12 inches or more in height) are common and shrubby cover either predominates or at least occurs as scattered clumps on the outer margins of the right-of-way and in the adjacent country. Trees may be present as scattered individuals or in woodlands between cultivated fields.

Type 2. Wooded Plateau Roads.—In this category are included roads along which the dominating vegetation is of tree or shrub size. Grassy margins or low herbaceous cover also may occur in varying degree. Bare cut and fill banks are common. Cultivated land and pasture may occupy a considerable part of the roadside land but sufficient scattered trees are usually present to serve as lookouts for raptors and perches for passerine birds.

Type 3. Western Plain Type Roads.—In this category are included roads where the dominating feature of the roadside cover is either grass or coarse herbs. Shrub-sized vegetation may occur in isolated clumps. Considerable areas of shrubby plants and even open tree growth such as the mesquite flats of the Southwest may be important features of the plain but usually trees are of such remote relationship to the roadside cover that fence posts become favorite perches for raptors and other birds.

TABLE 3

Region represented	Miles traveled	Destruction of wildlife observed			
		All species combined		Birds	
		Totals	Miles per individual	Totals	Miles per individual
East of Mississippi	5,505	152	36.21	22	250.23
West of Mississippi	6,723	667	10.08	84	80.03
Totals	12,228	819		106	

It is recognized that more accurate ecological designations of these habitats could be given. This has not been done because the use of such definite terms would imply an exactness of determination and a comprehensive quality which can not be properly credited to the observations made thus far in the study of wildlife destruction on the highways.

Two pertinent articles (6, 7) which appeared after this paper was submitted to the publisher are of sufficient interest to justify brief comment. The shorter one—by Russell and Amadon—is of interest because it records observations during a continuous trip from

Princeton, N. J., to Flagstaff, Ariz., that are directly comparable geographically with data recorded by the writer. Among other items these observers record an average of one bird to every 2.68 miles east of the Mississippi River and one bird for every 5.93 miles to the west. A recast of the writer's field notes to show a like distribution is given in Table 3. The writer's observations average one bird for each 260.23 miles east of the Mississippi and one for each 80.03 miles to the west, a rate of destruction about 3.1 times as great west as east of the chosen boundary, in contrast to Russell and Amadon who show a rate of destruction about twice as great east as west of the same line. This difference, although striking, is not too significant because at least two important factors involved are not directly comparable. The apparent differences illustrate quite markedly one of the outstanding features of the publications to date on highway mortality; i.e., the data have not been taken and published on such a basis that they all can be compared directly with statistical validity. The data of these authors are comparable with those of the present writer geographically but not from the standpoint of the seasonal distribution of travel in each province nor with respect to the ecological conditions reflected in the parts of each province covered. Both of these factors are regarded as important in the relative distribution and frequency of wildlife deaths on the highways.

Discussing the results in another way will show these influences more clearly. Although the writer traveled 1,218 more miles west than east of the Mississippi River, only two more days of travel west than east are represented. The seasonal distribution of travel between the two regions is, therefore, quite comparable as to opportunity for observations, quite different as to the cover conditions encountered. Also the writer's data cover a variety of seasonal conditions, while those of Russell and Amadon represent only one season. East of the Mississippi, 24 days or 80% of the travel time was in the months from November to May—when the rate of destruction is relatively low and in terrain which shows a low incidence of destruction—while to the west 23 days or 72% of the travel time was during the same group of months but very largely in the plains type of country which shows a high incidence of destruction. The influence of seasonal factors in the destruction of birds is reflected strongly in a closer analysis and comparison of the field notes. Of the 84 dead birds recorded west of the Mississippi, 79 were observed in the months of June, July, and October. Furthermore, 76 or 96% of them were recorded in four days of travel over 988 miles between Clinton, Okla., and Williams, Ariz., an incidence of one bird to 13 miles of travel, the highest encountered by the author. Of the 22 dead birds recorded east of the Mississippi, 21 or 95.5% were observed in the months of June and July in 967 miles of travel largely in the States of Tennessee, Georgia, and Virginia. Actually these 21 birds were observed in three days of travel through terrain of the piedmont and wooded plateau types. The incidence of deaths is one for 47 miles of travel. This comparison gives a relative rate of 3.6 times greater destruction west than east of the Mis-

sissippi as compared with the 2.2 times greater rate east than west reported by Russell and Amadon. Thus the difference in our findings as to rate of destruction is much less than at first appears. The most significant feature of the discrepancy is the reversal of geographical regions of high destruction. Russell and Amadon do not give an analysis of their data on the basis of cover conditions. It is worthy of note, however, that a considerable portion of highway US 40 traverses country having a roadside cover quite comparable to that called the plains type in this discussion. Also, a considerable mileage of US 66 runs through a section of Missouri and Oklahoma which in roadside cover, more nearly than any other, resembles that here listed as wooded plateau. The former has a high rate of wildlife destruction; the latter a much lower one. An unknown factor is whether Russell and Amadon attempted to limit their counts to freshly killed animals or counted all, regardless of the length of time they had been on the roadside.

Another item of interest is that birds constitute only about 13% of the total number of animals observed in the writer's study. In other investigations reported, the proportion of birds runs much higher. The writer has traveled much of the time in regions where resident-bird populations are relatively low and those of cottontails and jack rabbits relatively high. This may be an adequate explanation of the small proportion of birds represented but no conclusive statement concerning broad regional hazards is justified when so little is known of the resident populations from which samples are taken.

The article by Starrett (7) covers a complete seasonal cycle in a given environment. More studies of this type are needed. It is worthy of note that Starrett's data, although collected entirely in central Illinois, exhibit the same type of distribution as that shown in a cross-section for the country as a whole. It is believed that this feature is adequately accounted for by the influence of population density on the chance distribution of accidents. An additional point of interest is that Starrett's data give an average per mile mortality for the year for all vertebrates of .1180 as compared to the writer's figure of .1045 for the plains type of country; a difference of only .0135 animal per mile. This comparison has been made graphic by reducing Starrett's data to comparable values and including them in Figure 3. Starrett's totals are much higher than the writer's and have been reduced, therefore, to one-third their computed value to bring them in scale with the writer's presentation. Further comparison of data with respect to animal groups is interesting but would not contribute greatly to the present discussion. Although the subject is not treated at length, Starrett indicates that his observations were made in a locality having a relatively uniform roadside environment. It would be of value to have records from such an area that would show the relationship between wildlife fatalities and such variations as do occur in the roadside cover.

Russell and Amadon (6) state "With the exception of a few areas having a heavy population of soil-loving species such as the Nighthawk and Horned Lark, the writers found it evident that

along highways where roadside vegetation was scanty or had been removed, the number of dead birds was always low." Apparently Starrett considers the roadside cover to be of little significance, as compared to temperature, humidity, and precipitation. Thus we have additional evidence that the time is ripe for an experimental approach to this interesting problem involving wildlife populations. In the absence of adequate experimental evidence suggesting particular treatment, the writer is in favor of modified cover control rather than removal of all vegetation from roadsides. The maintenance of bare gravel on highway shoulders has certain features to recommend it in addition to any benefits wildlife may derive. Those advantages, however, do not pertain to that varying strip lying between the drainage ditch and the bounds of private property, that would seem to have great potentialities for management.

CONCLUSION

In conclusion, it should be emphasized that a practical experimental approach to solution of the problem of destruction of wildlife on highways by automobiles is not a search for means of eliminating such destruction entirely but rather of finding means to reduce to a minimum the death toll in each kind of highway environment. It is a subject of investigation that should enlist the cooperation of the wildlife manager, the landscape engineer, the horticulturist, and the highway engineer. Too frequently, such problems, if approached at all, attract the competitive interest of two or more of these professions instead of the cooperative efforts of all. The field observations that are on record to date suggest that roadside cover conditions most favorable to wildlife are entirely compatible with the maintenance of good drainage for the roadbed proper and of adequate protection against bank erosion on cuts and fills. These constitute two of the most difficult problems of the highway engineer. Planning quantity distribution of vegetation types offers abundant opportunity to the landscape artist with sufficient originality and courage to get away from present orthodox practices. In roadside plantings, why not let the escape ability and natural inclination of the native wildlife of the vicinity rather than the width, curvature, and length of tangents of the highway govern the distances between clumps of shrubbery? Why should not the food and cover requirements of wildlife receive consideration in the selection of plant species? Both landscape and wildlife objectives can be achieved with due regard to the safety of the public. May we not soon have a definite program of experimental study undertaken and adequately supported by some progressive highway department that will provide the needed facts on which to base an intelligent effort to make our highways less destructive of both wildlife and humans?

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SQUIRREL UTILIZATION OF OSAGE ORANGE

Upper (*R7-446*)—Fragments of Osage orange fruit left by fox squirrel. The fruit in the background shows a characteristic partly consumed condition.

Lower (*R7-447*)—The squirrels tear the fruit apart completely and overlook few seeds. Empty seed coats may be seen on the pile of pulp fragments.

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FOX SQUIRREL UTILIZATION OF OSAGE ORANGE IN KANSAS

H. L. Whitaker

During my residence in Kansas since the spring of 1935, I have observed extensive fox squirrel (*Sciurus niger rufiventer*) utilization of Osage orange (*Maclura pomifera*) seeds as food. Van Dersal includes the fox squirrel in his list of animals observed using the plant as a food source.[1] To my knowledge no other mention of this food habit has been published. This is surprising in view of the long period of availability of the fruit, the infallibility of its production, and its general utilization by squirrels. Despite the extreme droughts of the past few years, Osage orange has consistently borne fruit, and the seeds seem to be a favored food from the time they become firm of texture until well into the spring.

In Kansas leaf and stick nests are commonly used by the squirrels for summer and fall quarters, but during the cold months hollows in large trees seem to be required. Since the wood of Osage orange is extremely resistant to decay, and the diameter of mature trees is comparatively small, hollows are uncommon. It follows that year-round residence of fox squirrels is dependent on the presence of mature cottonwoods, elms, or other large species that more readily decay.

It is not certain whether Osage orange has been responsible for westward extension of the range of the fox squirrel in Kansas, nevertheless, the establishment of hedges around cultivated fields and pastures in the eastern two-thirds of the state has undoubtedly increased habitable territory within the squirrel's range. These networks of Osage orange trees now occur on areas where formerly the grassland limited fox squirrels to the wooded stream courses. Functioning as both feeding and breeding cover and as a source of food, the hedges commonly support a summer population of squirrels.

Fox squirrel management practices applicable to the prairie sections of Kansas within the area of successful establishment of Osage orange hedges include: Maintenance of large trees in sufficient numbers within the hedges for escape cover and for nest-building sites; and the preservation of adjacent mature cottonwoods and elms with hollows suitable for winter quarters.

[1] Van Dersal, W. R. 1938. Native woody plants of the United States, U.S.D.A. Misc. Publ. No. 303, p. 163. This is an Ohio observation reported by Dr. Charles F. Walker.

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SEASONAL MOVEMENTS OF A LOW-DENSITY VALLEY QUAIL POPULATION[1]

John T. Emlen, Jr.

Since 1935 the writer has made an intensive study of the individual and group behavior of the Valley Quail, *Lophortyx californica vallicola*, on a 760-acre tract of farmland in the Central Valley of California. The present paper describes the seasonal movements of these birds through a single year (winter, 1936–37 to winter, 1937–38).

The study was conducted on the farm and campus of the College of Agriculture of the University of California at Davis, in the middle of the broad flat Sacramento Valley, on the north branch of Putah Creek. Typical of the region, this tract is intensively cultivated and almost devoid of perennial quail cover. A narrow strip of scattered timber and brush along the creek forms the principal shelter, while shade trees and ornamental shrubs serve to hold a few birds around the farm and campus buildings. One hundred and thirteen quail (one per seven acres) were present on this tract on January 1, 1937, divided among four distinct coveys (Fig. 1).

The adjacent country for several miles around served as a check area and was examined at frequent intervals for supplementary information. Habitat conditions to the east and west along Putah Creek were essentially similar to those on the University Farm and the quail population there was of about the same density. To the north and south, away from the creek, perennial cover was limited to an occasional small farm-yard planting, and quail coveys were few in number.

Trapping was carried on throughout the winter and, by mid-February, eighty-six of the resident quail had been marked for individual field identification; each bird was tagged with a colored tail feather as an indicator of covey membership and with a combination of two colored leg bands, in addition to a numbered aluminum band, for identification within the covey. Detailed notes were kept on all sight records of these birds during the ensuing months. Conditions for observation were unusually favorable because of the sparsity of cover and because of the numerous roadways and open fields over which a closed car could be driven and used as a "blind." In approximately 700 hours of field observation 1,925 sight records were made on marked quail, an average of 31.3 (extremes of 5 and 88) for each bird that remained beyond April 1. In part of this work the writer was ably assisted by Walter E. Howard, to whom full credit is due for observations between May 13 and June 28. Valuable aid in routine work was also received from N. Y. A. assistants.

Winter Covey Territories

The four University Farm coveys (hereafter designated A to D) contained 23, 21, 23, and 46 birds, respectively,

[1] Contribution from the Division of Zoology, University of California, Davis, California.

on January 1, 1937. Each of these coveys restricted its winter wanderings quite closely to a well-defined covey territory, the boundaries of which were crossed only on rare occasions. The location and shape of these territories were seemingly dependent on the distribution of cover, while their extent was controlled by an undetermined factor that was apparently a function of the total area rather than of the linear dimension along any one axis. The four territories (Fig. 1 A to D) contained approximately 19, 22, 17,

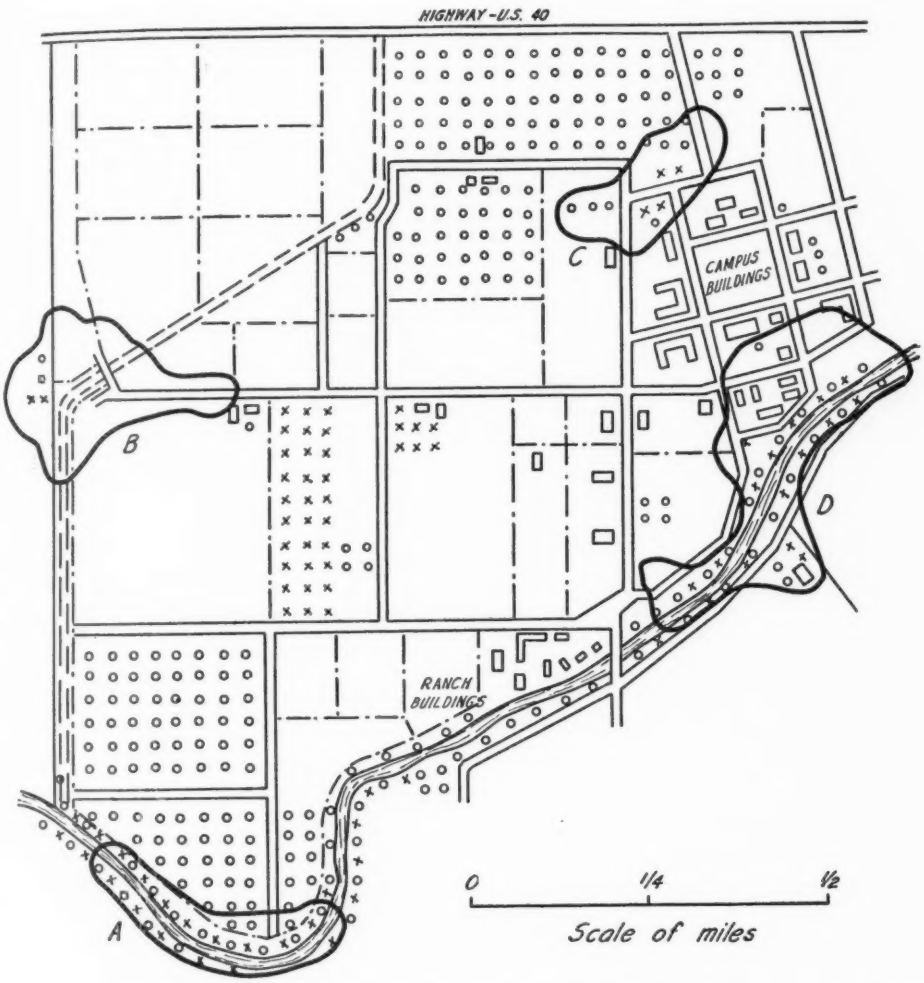

Fig. 1. Distribution of valley quail on the University Farm, Davis, California, winter of 1936–37. The four covey territories are bounded by heavy lines. Trees (shade and orchard) are indicated by circles (ooo), Brush (shrubs, perennial weeds, and vineyards) by crosses (xxx).

and 45 acres respectively, roughly one acre for each bird.

The members of a covey fed together in mid-winter in one, or occasionally in two compact groups. Only a fraction, rarely more than one-fourth to one-half of an entire territory, was utilized

Fig. 2. Foraging territories of five typical pairs of nesting quail on the University Farm at Davis during laying (dotted lines), incubation (solid lines), and the first month after hatching (dashed lines). o = nest site; + = roosting site during laying period.

by the birds on any one day. This fraction would serve as the habitual feeding ground of the covey for from a few days to two or three weeks when suddenly the birds would shift and use another section of the territory. In most cases a single roosting site served as the nightly gathering place of the covey throughout the winter regardless of where the birds had been feeding. Subsidiary roosting sites were, however, used at times in all of the four territories, and on several occasions a covey split between two or even three roosts.

COVEY INTERRELATIONS IN WINTER

The four winter territories were separated from each other by distances of from 350 yards to half a mile. It is not surprising, therefore, that contacts between the coveys were infrequent. The only two instances of this which were noted during the winter of 1936–37 are here described in detail because of the striking evidence they provide of a "social barrier" between the coveys.

Contact between coveys C and D (normally separated by 350 yards) was observed on November 15, 1936, at 7:00 A.M. Covey C members (identified by yellow artificial tail feathers) had wandered over the southern border of their territory at a time when the birds of covey D (green tails) were feeding only 75 yards away at the extreme northern edge of theirs. There was much calling back and forth and presently 14 of the 28 members of covey D approached and merged with the 23 birds of covey C. The mixed covey thus formed proceeded northward onto territory C where all the birds intermingled freely, and apparently without animosity, for half an hour. Observations were interrupted at this point. On the observer's return eight hours later, the green-tailed birds were lagging behind the actively feeding resident covey in a more or less separate group. Covey C males apparently no longer tolerated close proximity of the intruders and drove them back repeatedly. At dusk, when the resident birds retired to their habitual roost, the alien birds of covey D acted as though confused and finally scattered irregularly among several roosting trees of inferior quality. When next observed, at 7 o'clock the follow-

ing morning, all but one of the wanderers were back with their covey mates on their own territory. The one laggard, a yearling male, in the absence of its usual associates, attempted to attach itself to covey C, but was singled out by the resident males of that group and attacked viciously every time it attempted to approach. Two days later it had found its way back to territory D and segregation of the two groups along the original covey lines was completed.

The second instance was not as clear-cut as the first, but illustrates again the principle of social exclusiveness. On February 16, 1937, covey C wandered as a group onto the northern edge of territory D (possibly as a result of certain disturbances and accidents on its own territory). Although the two groups were repeatedly seen within a hundred feet of each other during the last ten days of February, they were never observed to combine or intermingle in any way. With the arrival of the period of mate selection and spring restlessness, covey C broke up and left only one member, an unmated yearling male, on territory D. This individual, in the absence of other associates, took a lively and persistent interest in the resident covey which still contained twelve birds. It was, however, never able to penetrate the barrier of exclusion. Every approach it made to within 5 yards of the covey drew an attack from a resident male which put it to rout. Apparently recognizing its ostracism, this bird was invariably found alone at the edge of the covey. On March 4 it took advantage of a sickly and dying female which lagged, unprotected, behind the moving covey and twice copulated with her. On March 18 it evinced much interest in one of two unmated females, which with a single unmated male, formed an isolated group. Time after time it approached, hesitatingly, only to retreat as the male chanced to turn in its direction. It was last seen on March 24, still unmated and still unaccepted by the resident quail.

The behavior of these birds definitely points to the existence locally of a social barrier between the coveys. Price (4) has observed a similar exclusiveness in the social organization of "color-marked" quail in the denser populations at Palo Alto. Game farm managers report that penned flocks exhibit a definite intolerance for strange birds put in with them. In the opinion of the writer, this behavior trait is a universal characteristic of the species and possibly of all covey-forming quail rather than the peculiarity of a few local groups that have been studied in detail by the "color marker" method. Trapping and direct enumeration were insufficient in themselves to demonstrate the details of inter-covey relationships on the sparsely populated University Farm, and it is very doubtful whether, even in highly skilled hands, such techniques are capable of revealing the true situation on heavily populated areas. Where quail are abundant, covey contacts are frequent and the social barrier is apparently less rigid. Thus Stoddard (5), on the basis of trapping data, conjectured a free interchange between the closely spaced coveys in his Georgia area. Errington (1), although he noticed a tendency for individuals to stick together, saw many instances of readjustments in covey size in Wisconsin.

TABLE 1

ANALYSIS OF THE VALLEY QUAIL POPULATION ON THE UNIVERSITY FARM, DAVIS, CALIFORNIA, IN 1937[1]

	Marked Adults					Unmarked Adults[2]		Total of Adults	Young of 1937 Broods			Total Adults and Young
	Yearlings of 1936 broods		Older Birds		Total							
	♂	♀	♂	♀		♂	♀		♂	♀	Total	
Jan. 1	29	25	21	10	86	16	11	113				113
10	28	25	21	10	84							
20	27	21	21	9	78							
Feb. 1	25	21	21	9	76	11	6	93				93
10	23	19	21	9	72							
20	21	19	18	9	67							
Mar. 1	17	16	14	7**	54	12	5	71				71
10	10	13	12	7	42							
20	9	11	12	7	39							
Apr. 1	7	9	11	7	34							
10	5	9	11	5	30							
20	5	9	11	5	30							
May 1	5	9	11	5	30	12	5	47				47
10	5	8*	11	5	29							
20	4	8	11	5	28							
June 1	4	8	11	5	28						15	
10	4	7	10	5	26						15	
20	4	7	9	4*	24						41	
July 1	4	7	8	4	23	8	4	35			50	85
10	4	5*	8	4	21						48	
20	4	5	8	4	21						57	
Aug. 1	4	4*	8	4	20						73	
10	5	4	7*	4	20						67	
20	5	4	7	3*	19						73	
Sept. 1	5	4	7	3	19						71	
10	5	4	7	3	19	7	4	30			68	98
20	5	4	7	2	18				42	26	68	
Oct. 1	5	4	7	2	18				42	25	67	
10	5	4	7	2	18						61	
20	5	4	7	2	18				35	25	60	
Nov. 1	4	4	6	2	16							
10	4	4	6	2	16	8	2	26	35	25	60	86
20	3	3	5	1	12							
Dec. 1	3	3	5	1	12				34	25	59	82
10	3	3	5	1	12							
20	3	3	3	1	10							
31	3	3	3	1	10	8	1	19	34	25	59	78

[1] This population record is peculiar for its high adult mortality. Losses incurred in trapping are indicated with an asterisk (*).

[2] Numbers of unmarked birds are approximate.

The fact that these men and Sumner (6), Gorsuch (3), and Glading (ms) did not detect a "social barrier" in covey organization is no proof of its non-existence. It may well have been present but obscured by the general complexity of the social relations and the inadequacy of field technique not especially designed to reveal it. The final test of the existence and potency of the social barrier under various environmental conditions and population densities must await further use of techniques which enable one to follow the movements of individual birds by direct observation.

SPRING DISPERSAL

The nesting season brought with it a complete change in the social organization and local distribution of the quail. The winter covey units, with their well-bounded territories, gradually disintegrated during the spring and by summer had been replaced by a looser social organization of independent pairs and unattached males, widely scattered over the countryside.

The break-up of the coveys was accomplished in two distinct steps or phases. Nearly half of the local birds took part in the extensive movement which constituted the first phase. Starting about February 20, all four coveys began to lose members rapidly, and by April 1, 33 of the 67 marked quail had disappeared (Table 1). New (unmarked) birds arrived from the outside at the same time but generally moved on, being discouraged by the social barriers which still persisted around the resident coveys; the few that remained by no means compensated for the heavy loss of residents.

Just what became of these "lost" birds was not fully determined. A few of them died, a larger number moved away from the winter population centers, presumably to the open farm land which, up to this time, had been uninhabitable for quail because of inadequate cover. Farmers on these areas reported that they had noticed a spring influx of birds onto their properties as a regular annual occurrence, and, although only a few of the marked individuals from the University Farm were ever recovered, it is highly probable that this is where many of them went.

The distances travelled by these emigrants were apparently considerable. Of the 34 quail which disappeared from their coveys at this time only one remained within the confines of the University Farm. One male moved down the creek a mile and a half before becoming established for the nesting season; another was shot on November 25, 1937, four miles "inland" from its creek-bank territory of the preceding winter. Three birds (one male and two females), after absences of from four to eight months, returned to the winter range on the Farm. Two females were killed locally early in March. The fate of the other 26 was not ascertained.

The period during which this emigration from the coveys took place coincided almost exactly with the season of pairing-off within the coveys. These two activities, furthermore, appear to be closely related. While only a little fighting of the type described by Sumner (6) and others was observed, a competition within the coveys for mates is strongly suggested by the selective nature of the covey reductions. Mated birds generally survived

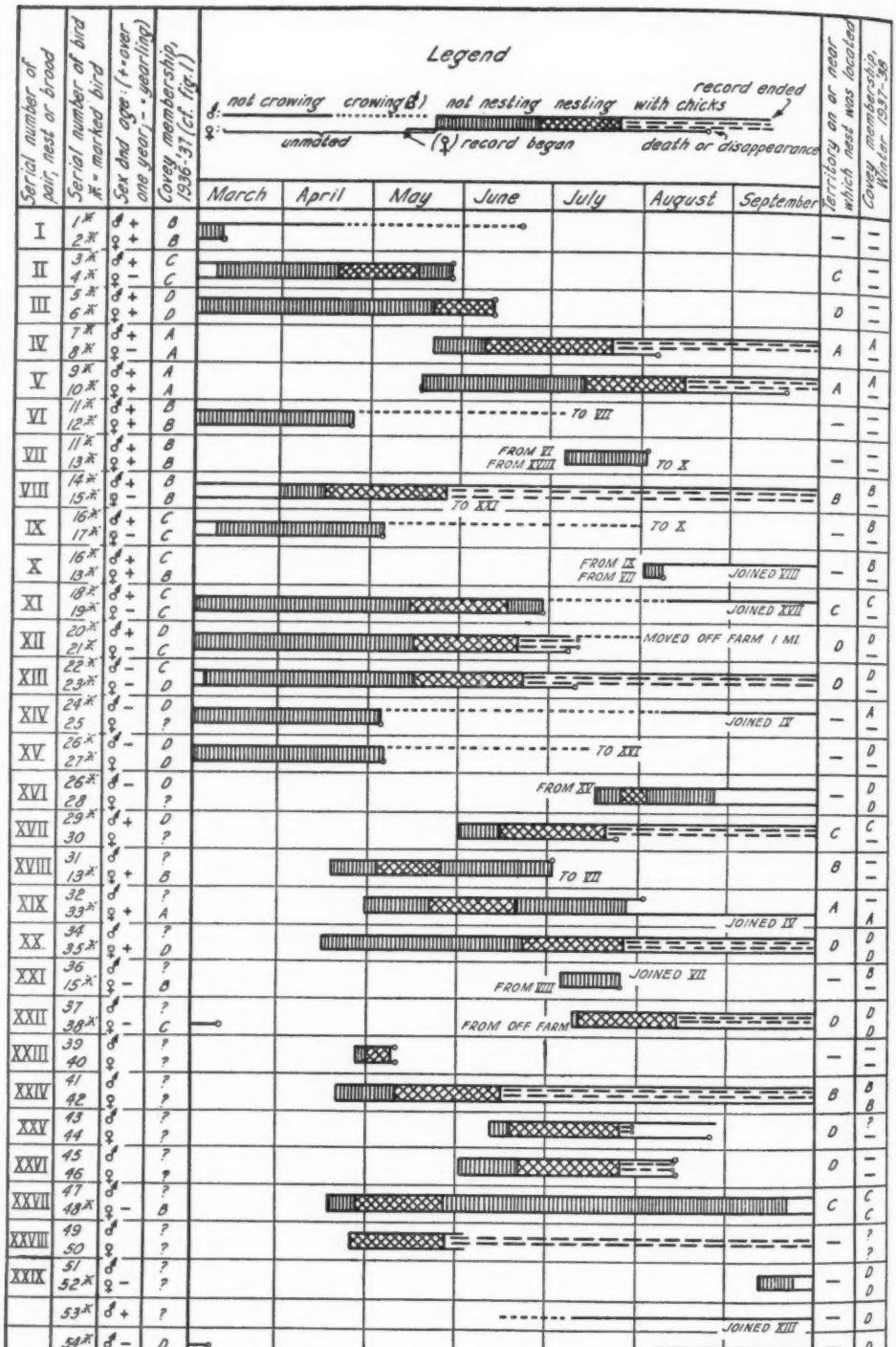

Fig. 3. (*See opposite page for explanation.*)

the emigration period, while the unattached individuals, slower in securing mates, disappeared one by one.

All four coveys lost more males than females; thus the disproportionate sex ratio of 39 males to 28 females on February 20 was, through the elimination of surplus males, roughly balanced at 18 to 16 by April 1.

Age is another factor which apparently had a selective value. In the case of the males, 14 of the 21 birds lost were yearlings. In fact, of the 21 yearling males present on February 20 only one survived the various spring and summer "weeding processes" to remain and nest on its home (winter) territory, while 7 of the 18 older males nested "at home" (Fig. 3). Yearling females were even less successful in competing with their elders, for all of the 9 females lost in this period were young hens. The number of yearling females was thereby halved, while the old females did not lose a single bird.

Weight apparently had no definite bearing on survival in this period of depletion. Twenty-one dislodged males averaged 179 grams (winter weight) as against 178 grams for 18 survivors. Nine females that disappeared averaged 169 grams while 16 surviving females averaged 172 grams.

The second phase of the spring dispersal began about the middle of April. By that time the first phase had been completed as indicated by the leveling off of the population curve after its steep deline in March. All except the surplus males were paired off, and yet covey territories were still intact and essentially unchanged. The second phase involved the actual breaking down of the territorial and social boundaries of the coveys and the dispersal of the birds locally onto the intervening regions. Within a single month, that is by May 15, the occupied quail range, which in the four winter territories had comprised about 105 acres, was extended to approximately 550 acres. Only non-nesting (late-nesting) birds continued in close (covey) association around the winter roosting sites, and by the end of June these also were gone.

SUMMER MOVEMENTS

During the summer months quail were quite localized and sedentary in their habits despite the comparative abundance and wide distribution of food and cover. Their restricted movements can best be considered under two headings: (a), movements of unmated males; (b), movements of mated pairs.

As already pointed out, there were more males than females on the study area from the beginning. Most of these surplus males were lost in the early spring emigration, but a small number remained, and from 2 to 6 were always present in the local population during the summer (Fig. 3). Unmated males were relatively unobtrusive during the mating period, but after April 19 (the beginning of the nesting season) they assumed an antisocial and noisy

Fig. 3. Individual histories of the Valley Quail of the University Farm at Davis, California, during the summer of 1937 with a graphic summary of the mating and nesting activities of each bird. All individuals that were present after April are included. Legend at top of chart.

behavior. Intolerant of others of their kind, they scattered widely over the nesting grounds to announce their presence and lonely condition with the single "cow" note or "crow."[2] This crowing was almost always directed toward the female of an established pair, much to the annoyance of her mate. An active crower would occasionally advance to within a few feet of such a pair, but was ready to beat a hasty retreat if too close an approach brought a challenge from the mated male.

No single rule can be made as to the motility of unmated "crowers." Of the eight marked individuals on the University Farm during the summer, four (nos. 1, 16, 20, 24—see Fig. 3) lived a nomadic existence and four others (nos. 11, 18, 26, 53) were decidedly sedentary. Each bird in the latter category restricted itself to a small crowing territory near the nest of an established pair. A series of crowing perches was utilized on such a territory and no unmated trespassers were tolerated. Territories were deserted at night in favor of a common roost of non-nesting birds.

The four nomadic "crowers," upon assuming the crowing habit, wandered extensively, sometimes covering as much as a mile in a single day. Regional boundaries, however, were recognized even by these birds and each confined its attentions to a limited number of nesting pairs. One of them (no. 24), after a month of this sort of wandering settled down on a small crowing territory; the others remained confirmed nomads as long as they were unattached.

Although mated pairs did not set up nesting territories in the usual sense of the term, they were, under normal conditions, decidedly limited in their movements during the breeding season. During laying they confined their foraging to areas of from 12 to 25 acres, generally retiring at night to a communal roosting site with neighboring quail (Fig. 2). With the beginning of incubation, the feeding range was narrowed to the half dozen odd acres (3 to 10) in the vicinity of the nest. Males continued to retire to the communal roosting site for the night while the females remained on the eggs. Movements were further restricted during the first two weeks with the brood, but thereafter they gradually expanded as described later in this paper in the section on "Fall Movements."

Deviations from this "normal" course of events were common. Due to nest failures of one sort or another 8 of the 20 pairs which bred on the University Farm were liberated from the restrictive nesting ties before incubation was completed. In 5 of these (nos. XI, XVI, XVIII, XIX, XXVII—see Fig. 3) the birds remained close to the abandoned nest site without apparently attempting to renest. Three other pairs (nos. II, III, XXIII) disappeared shortly after the nest failure. These latter birds, together with 3 new pairs (nos. XXII, XXV, XXIX) which appeared on the Farm during the same period, possibly represent a summer movement of unsuccessful pairs. The female of one of these pairs (no. XXII) had disappeared from the area in the early spring emigration.

[2] This note is sometimes given by the male of a mated pair when the female is not with him.

More frequent than nest failures and more important from the point of view of social and territorial relationships are the mate losses and mate replacements. Of the 29 pairings observed at one time or another during the course of the nesting season, only 7 (nos. V, XVI, XX, XXII, XXIV, XXVII, XXIX) were still intact at the end of the summer. Thus 22 pairs suffered accident of one kind or another. Of these, 15 were disrupted by the death or desertion of the female; 3 (nos. VII, XVIII, XIX), by the death of the male, and 4 (nos. II, III, XXIII, XXVI), by the disappearance of both members of the pair.[3]

When the male of a pair was lost, the widowed female, if not nesting, acquired a new mate from amongst the unmated crowers of the vicinity within less than two days (nos. VII and XVIII) or else attached herself to a local brood of chicks (no. XIX).

Males which had lost their mates during the nesting season, unless they had chicks to guard, assumed the crowing habit within a day, either locally or (in 4 cases) at points of from ¼ to 1½ miles away.[4] At least 8 of the 19 marked males spent part (up to 91 days) of the summer in an unmated condition as a result of losing a mate; in fact, only 2 are known to have been mated without a break through the entire summer.

The shuffling, both marital and geographic, which resulted from these accidents and irregularities in the nesting procedure was the most important single factor in the realignment of birds for the 1937–38 winter coveys.

[3] The fate of one pair (no. XXVIII) was not determined definitely.

[4] In one case in *1936* the male took over incubation duties.

FALL MOVEMENTS AND COVEY FORMATION

The reassembling of the summer stragglers into the new 1937–38 winter covey formations actually extended over a period of six months, from the hatching of the first brood (May 25) until the last sub-covey merger (November 25). By the middle of August nesting was over and 9 new covey nuclei, in the form of broods, had been established. These, serving as the foci for the convergence of summer stragglers, eventually merged to form the new coveys of the 1937–38 winter season.

The motility of broods was ordinarily restricted to a few acres for the first week or two after hatching. Thereafter foraging territories were gradually expanded until, when the chicks were a month old, they covered 10 to 20 acres around the old nesting site.

Extensive shifts to new territory occurred when environmental conditions were unfavorable. Broods VIII and XXIV were forced to move distances of 300 and 400 yards respectively, when less than two weeks of age, because of the destruction of cover on their original territories. Brood XX, apparently under the influence of the older chicks of brood XIII, shifted headquarters a distance of about a quarter of a mile when 35 days old. Brood XXVIII (2 chicks) moved out when 10 weeks of age and reestablished itself on new territory a full mile away. (This brood had been without adult escorts since 4 weeks of age.) A sedentary existence, however, was normal, and 8 of the 9

broods raised on the University Farm (all except XXVIII) eventually wintered on the covey territory on which, or nearest which, their place of hatching had been located (Fig. 3).

The development of broods into sub-coveys by the incorporation of unsuccessful local adults and of other broods was regulated in part by the social relations and tolerances of the birds during this period. Immediately after hatching a definite social barrier was thrown around each brood by its parents. This was gradually lowered as the chicks grew older.

Among the various classes of local adults, the first to be admitted through the circum-brood barriers were the resident pairs that had been unsuccessful in nesting; indeed, it is questionable whether these birds were ever rigidly excluded. Such broodless adults, particularly the males, showed great interest in young chicks and, when admitted, made as good guardians as the true parents (2 instances). Mated pairs still involved with their own nesting duties were accepted by the parents of broods without alarm, as the former were generally too pre-occupied to evince particular interest. Crowing cocks showed an insatiable interest in young broods, but were rigidly excluded as long as they persisted in the crowing habit (up to August 10). By that time the nesting season had nearly ended and the active interest of independent adults in the broods was waning rapidly. The aggregations, consequently, developed slowly during the fall, and it was not until October 5 that the last of the stragglers was incorporated.

The 9 local broodless adults showed no tendency to migrate or wander extensively during the period of covey formation. They simply evacuated the temporary summer parts of the range, a few at a time, to join the nearest and most convenient of the sub-covey aggregations. Four outsiders, however, made their appearance at this time from points unknown; these included two of the early spring emigrants.

The incorporation of miscellaneous adults into the sub-coveys formed the primary step in covey formation; the second step, operating simultaneously, consisted in the combining and merging of neighboring broods and sub-coveys. Parents (and other adult escorts) were wary of neighboring broods until their own chicks were two weeks or more of age. When 3 or 4 weeks old the parents occasionally allowed their charges to mingle with others of similar age for short periods. The 4 brief contacts of this type that were observed never altered the respective numbers of the two groups involved, and it is believed that no intertransfer of chicks occurred on these occasions; observations on 6 marked chicks in 2 broods substantiated this belief.[5] Older and larger chicks were not tolerated in a young brood until after the fourth or fifth week, by which time the size of individuals in the two groups was less diverse. Contacts between neighboring broods became more frequent and intimate during the second month of life until they became habitual, and complete mergers were formed. The 9 broods surviving on September 1 thus became 6 sub-coveys by October 15.

[5] Price (correspondence) found that a certain amount of intermixing occurred between neighboring broods at Palo Alto.

With the condensing of the population and the evacuation of summer range, the distribution of the local quail became discontinuous, breaking up into a number of circumscribed and isolated territories. The infrequency of intergroup contacts which resulted may in part account for the display of animosity which was observed on two occasions. Broods XXIV and VIII encountered each other, probably for the first time, on September 15, when 12 and 16 weeks of age respectively. Brood VIII, upon hearing rally calls just outside their foraging territory, responded, approached rapidly and without a moment's hesitation attacked the strangers *en masse*. A rather noisy and vicious encounter ensued, whereupon, after 3 or 4 minutes, the combatants lost interest, separated, and retired to their respective territories. Again on September 16, two sub-coveys, probably unaquainted, were observed in a mass encounter of lively activity but short duration.[6] Such incidents undoubtedly tend to discourage frequent and haphazard mergers between sub-covey aggregations during the fall.

Despite this exclusiveness of sub-coveys, two mergers took place in the latter part of November under the pressure of (1), hunting on adjacent lands; and (2), drastic reduction of roosting cover through the falling of the leaves in the orchards. This finally condensed the Farm population onto four covey territories, almost identical in location and boundaries with those of the previous winter.

Of the 12 marked adults still surviving on the University Farm on December 1, 1937, 8 (6♂♂, 2♀♀) were back on the same territories they had occupied during the previous winter and 4 (2♂♂, 2♀♀) were located in other territories. The majority of the 11 unmarked adults were undoubtedly immigrants from extra-Farm coveys of the 1936–37 season. (If the survival was proportional in marked and unmarked birds (Table 1) only 2 or 3 of the latter were carried over on the Farm from the 1936–37 winter season.) Thus, only half or less than half of the 23 adult quail on the University Farm in December 1937 were reoccupying the territories they had inhabited the previous winter.

[6] Errington has observed similar behavior in bobwhite quail in Iowa (2).

SUMMARY

The Valley Quail on the University of California Farm at Davis were followed closely through the year 1937 by means of colored leg bands and tail feathers. The present paper describes their movements under the following headings:

1. Winter covey territories. The four covey territories under study varied from 21 to 45 acres in extent, and from ¼ to ½ mile on the longest axis. Only 5 to 10 acres were normally utilized in any single day and shifts from one section of a territory to another were made at irregular intervals of from a few days to several weeks.

2. Covey interrelations in winter. Extraterritorial movements of coveys were restricted by inter-covey social barriers. Trespassers from other coveys were recognized and excluded.

3. Spring dispersal. The break-up of coveys for the nesting season involved two distinct steps or phases: (1) an early spring emigration of unmated in-

dividuals (mostly yearlings) to distant points; and (2), a dissolution of covey boundaries to release the survivors of phase 1 onto the local nesting areas.

4. Summer movements. Quail movements during the summer period of food and cover abundance were restricted by nesting duties and, in the case of unmated males, by an active interest in nesting pairs. The individual movements which occurred were generally local and resulted from the numerous irregularities and accidents of the nesting season.

5. Fall movements and covey formation. Despite preliminary displays of social intolerance nine broods, augmented by 13 unattached summer stragglers, merged, by October 15, into 6 subcoveys and finally, by November 25, into 4 covey formations. The territories of these coveys closely approximated those of the previous winter. Less than half of the 23 old birds present on December 1, 1937, had been residents of the same territories the previous winter.

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ELIMINATION OF YELLOW PERCH FROM A LAKE BY USE OF DERRIS ROOT

Maynard B. Barrows

For a number of years officials of the National Park Service have realized that the Yellow Perch (*Perca flavescens*) in Goose Lake of Yellowstone National Park were a potential threat to other waters to which they might be either intentionally or accidentally transferred, and, further, that they were serving no good purpose as they were undersized and furnished little or no sport for fishermen. In 1893 an attempt was made to stock this lake with bass but the fish died in transit. Two years later the Superintendent's Annual Report records a plant of 500 black bass in the four Upper Basin lakes, one of which may have been Goose Lake. Possibly perch were planted at this time unknowingly, or they may have been stocked at some later date, but there is no further mention of this lake until 1919 when, according to the record, perch were caught for the first time.

In 1936 a hydrographic survey was made of the lake and means of eliminating the perch were considered. Dr. Leonard P. Schultz[1] suggested four possible ways of killing the fish, namely, with dynamite, calcium hypochlorite or chlorinated lime, copper sulphate, or derris root with 5% rotenone content. It was decided that using derris root would be best as aquatic vegetation would not be killed and insect life would suffer less than if chlorine or copper sulphate were used. A further advantage was that rotenone would not poison warm-blooded animals that might drink the lake water or eat the fish after they were killed. Moreover, the effect of derris root ceases in a few days so that fish could again live in the lake.

Funds for this project were not made available until the summer of 1938, when it became possible to accomplish the work in connection with the C.C.C. program. The plan that was followed was essentially that suggested by Dr. Schultz.

From the hydrographic map it was found that Goose Lake had an area of 37½ acres and contained 952 million pounds of water. A small stream enters the lake but there is no surface outlet. The maximum depth is 25 feet.

Dr. A. S. Hazzard, Director, Institute for Fisheries Research, Ann Arbor, Michigan, who had conducted a number of recent experiments with derris root, estimated that 500 pounds would be sufficient (40 pounds were added as a safety factor). It was decided to distribute the derris root as follows:

From motor boat—strip method	450 lbs.
Deep water treatment	20 lbs.
Shoreline treatment	60 lbs.
Stream treatment	10 lbs.
Total	540 lbs.

It will be seen that most of the fish poison was to be distributed by motor boat. In order to get an even spread the lake was divided into 50-foot strips,

[1] Dr. Schultz at that time was working with the Bureau of Fisheries and is now with the Division of Fishes, U. S. National Museum, Washington, D. C.

forty of which were required. Each boundary was marked with numbered stakes on opposite shorelines. Two C.C.C. boys were drilled to act as flagmen on these strips.

Allotment of derris root to the strips was calculated by multiplying strip length by average depth, giving the number of units in each strip, the quantity per unit being determined by dividing the 450 lbs. assigned to the strips by the total number of units in all of the strips. The number of pounds for each strip was then calculated, weighed out, and placed in a sack numbered to correspond with the strip.

To get the poison well mixed in the deeper parts of the lake, 32 bombs were prepared, each composed of three or four sticks of dynamite and one-half to three-quarters of a pound of derris root wrapped in burlap. The fuse on each bomb was greased to prevent wetting and thus to avoid the possibility of duds. Two flags were set up on opposite sides of the lake to mark the zone of greatest depth.

For the shoreline crews, poles were provided for stirring the derris mixture around the vegetation in shallow water; three to four pounds of derris root was wrapped in sacking and attached to the end of each pole.

Although no perch could be seen in the small inlet stream, it was decided to treat about one-half mile of this creek and in order to avoid repopulation from above three screens were installed. It was planned if the lake treatment proved successful to treat the upper part of the stream later.

On September 9, 1938, the area was treated with the derris mixture according to plan. The stream was worked first, with the temperature of the water at 48°F. No perch or other fish were found.

The distribution of derris solution from a boat fitted with an outboard motor and the shoreline treatment were started at the same time. The average temperature of the lake water while the work was being done was 60°F. The derris solution was mixed on the shore in ten gallon cans, each of which was tagged with a number corresponding to that of the strip on which it was to be used. In mixing the solution to a soupy consistency in the cans it was found that ten pounds of derris root could be mixed with an equal amount of water by stirring vigorously, but when the amount of derris root was increased over a half and half ratio the mixture was poor. When properly mixed the solution resembled chocolate malted milk. The mixture was poured from the side of the boat continuously on each strip. It was necessary for the man who did the pouring to gauge the depth of the strip carefully in order to make the supply cover the whole strip. The action of the boat propeller mixed the solution with the lake water quite well but to further the process another boat equipped with an outboard motor followed the distributing boat. The second boat also towed two buckets below the surface which helped in the mixing process.

The shore line treatment was handled by two crews of eight men each. The entire shoreline was stirred and prodded with the derris-carrying poles previously described. Small quantities of derris root also were mixed in buckets and thrown along the shoreline. One crew used a row boat to treat areas

where vegetation was growing out from the bank on floating islands. Most of these islands were also blasted with small quantities of dynamite. The shoreline was completely covered twice by the treating crews.

All of the derris solution was distributed in about three hours. The bombs were then set off in the deep parts of the lake; all but two of them exploded. The boats were kept running back and forth across the lake about five hours.

The first effects of the solution on the fish were noted 20 minutes after distribution had started. Shortly afterwards hundreds of perch were skipping along on top of the water and others were jumping out of the water onto the shore. Their average size was between four and five inches and the largest specimen found was eight and one-half inches long and weighed one-quarter of a pound. Some eight hours after the treatment began great numbers of fish had died but there were still many others struggling in the water. Two counts were made along the shoreline covering reaches 50 feet in length; 229 dead perch were found in one of these units and 336 in the other. It was estimated that the sample plots were representative of one-third of the shoreline and that there were no dead perch on the remainder of the lake margin. There was approximately 6,700 feet of shoreline and it was estimated that 11,000 or 12,000 perch were killed. This is thought to be a conservative calculation as many of the fish sank to the bottom after they died and were not washed ashore.

On the following morning no live fish could be seen and from all appearances the project had been successful. Two flocks of ducks (mostly mergansers), two kingfishers, and a marten were enjoying the feast. Sea gulls and numerous other waterfowl also fed on the fish without ill effects so far as noted. Occasionally a bear has stopped along the shoreline to sample the fish.

On September 30, one bay of the lake was treated with five pounds of derris root to test whether any live perch remained. No fish of any kind appeared and the result was corroborated by several unsuccessful fishing attempts. It was, therefore, concluded that the perch had been eliminated from Goose Lake.

The cost of the derris root was 32¢ per pound which, with freight charges, amounted to approximately $192.00 for the quantity used. Other material included a box of dynamite, caps, a roll of fuse, and burlap sacking. Twenty-two C.C.C. workers, two C.C.C. foremen, one Bureau of Fisheries man and four rangers worked on the project for one day.

Maynard B. Barrows
Yellowstone National Park
Yellowstone Park, Wyoming

WHEN DO TROUT AND GRAYLING FRY BEGIN TO TAKE FOOD?[1]

C. J. D. Brown and Charles Buck, Jr.

There is considerable difference of opinion among fish-culturists as to the time when trout and grayling fry should receive their initial feeding. The most common practice is to offer food when the fry first "swim up," i.e., at the time when the fish have absorbed sufficient yolk to enable them to rise from the bottom of the hatchery trough and remain up in the water, at least for a limited time.

Henshall (1904, 1907) fed trout and grayling fry before the yolk sac was entirely absorbed. Leach (1923a) reports that brook trout begin to feed as soon as the yolk sac diminished sufficiently to allow the fish to rise and that grayling fry (1923b) began a search for food about one week after hatching. He indicates that rainbow fry should receive food at the time when the umbilical sac is absorbed. Steuert (1901) found that brown trout first ingested food 31 days after hatching and that by the 35th day almost 100% of the fish were feeding.

The interesting experiments of Atkins (1905) showed a greater mortality in brook trout fed early than in those deprived of food for five days. Fasting beyond the fifth day increased the rate of mortality in brook and lake trout but not in silver salmon. He questions the practice of very early feeding even though the fry are capable of taking food.

[1] Contribution from the Institute for Fisheries Research, Michigan Department of Conservation and University of Michigan.

Some experiments designed to secure definite information on the time of initial feeding in trout and grayling were undertaken at the Bozeman Station of the U. S. Bureau of Fisheries. During the spawning seasons of 1937 and 1938 observations were made on the feeding time for the following species: brown trout (*Salmo trutta*), rainbow trout (*Salmo gairdnerii irideus*), cutthroat trout (*Salmo lewisi*), brook trout (*Salvelinus fontinalis*), and Montana grayling (*Thymallus montanus*).

We are indebted to Fred J. Foster, Regional Director of the U. S. Bureau of Fisheries, who made the facilities of the hatchery available for these experiments, and to Superintendent Charles Fuqua and Hubert Topel for assistance in the experiments.

Methods

The trout and grayling eggs were hatched and the resulting fry were held in standard hatchery troughs. The water supply for all experiments came from the same two springs (temperature 47°–52°F.). This water contained practically no organisms which might have been utilized as food.

The experimental fry were fed on the more or less standard ration used in starting young fish. This consisted of beef liver and, in one or two cases, beef heart and salmon carcass meal. The food was prepared and fed in the usual manner except that it was ground more finely and introduced into the water with special care.

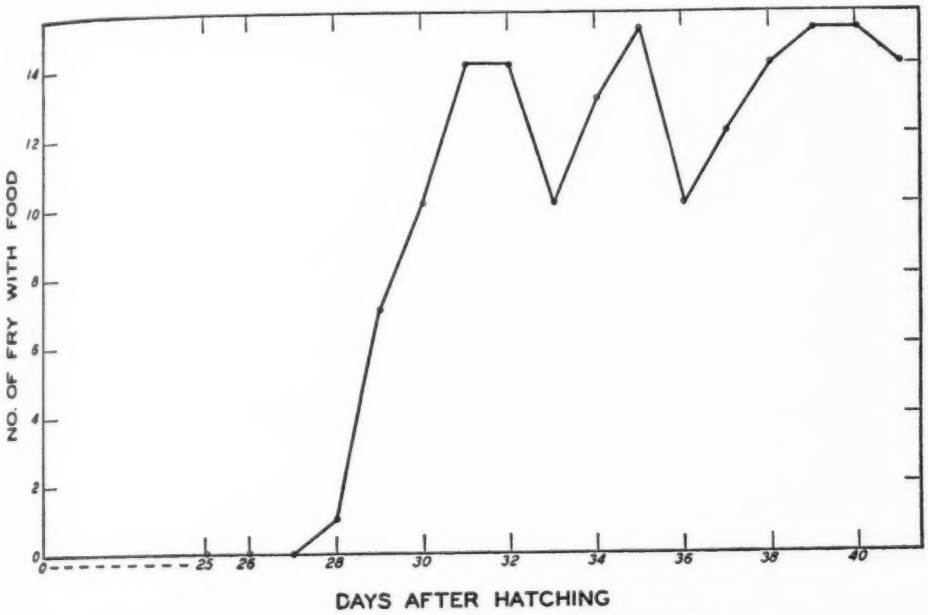

Fig. 1. Time when brown trout fry (*Salmo trutta*) began to ingest food.

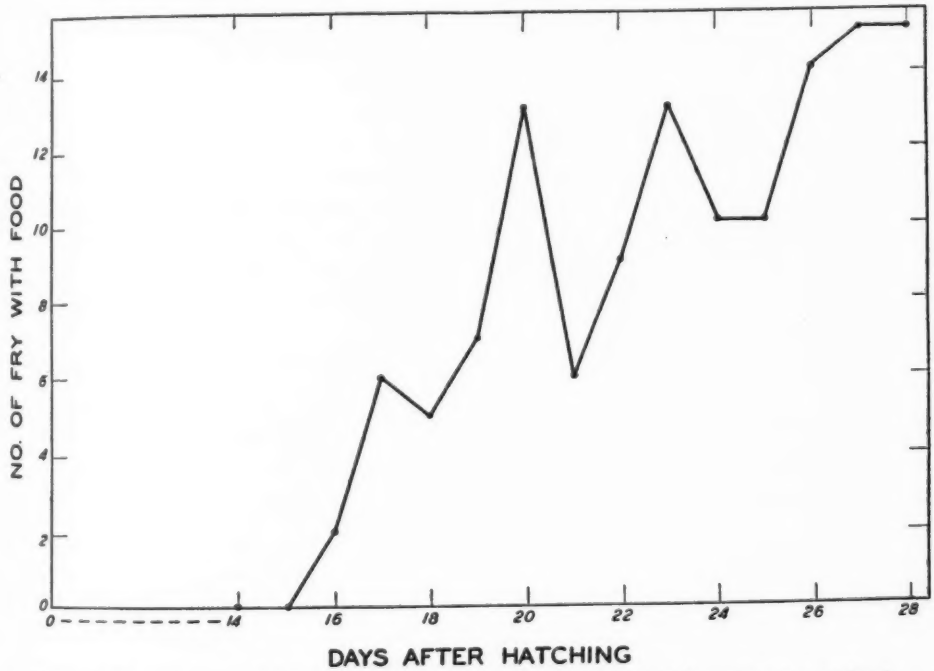

Fig. 2. Time when rainbow trout fry (*Salmo gairdnerii irideus*) began to ingest food.

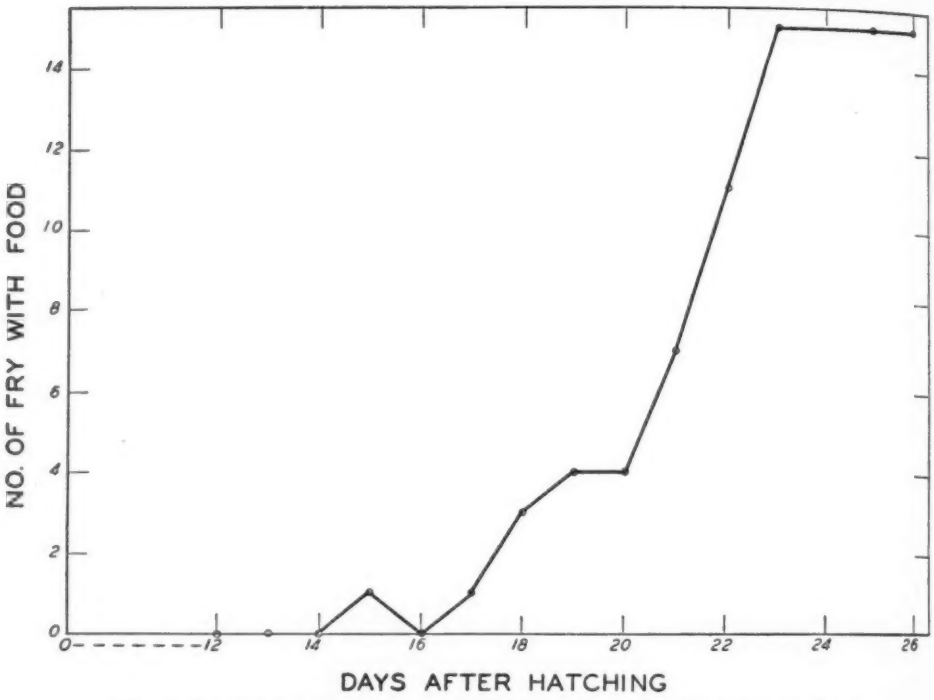

Fig. 3. Time when cutthroat trout fry (*Salmo lewisi*) began to ingest food.

Feeding was initiated several days before the trout fry became active and the day after hatching in the case of the grayling.

Thirty to sixty minutes after each feeding 15–25 fry were preserved, and later examined for stomach and intestinal contents.

Feeding Experiments

Brown Trout Fry (Fig. 1.)

Brown trout eggs taken November 19 from Madison River (Montana) hatched December 28. The first food (consisting of finely ground beef liver) was offered January 21, twenty-five days after hatching, just as the fry made their initial effort to "swim up." Sixteen fish were examined, 30–45 minutes after the morning feeding each day.

The first evidence of stomach contents appeared 27 days after hatching. By the 31st day practically all fish had stomach contents. This agrees almost identically with the results of Steuert (1901).

The water temperature remained at 52° F. throughout our experiment.

Rainbow Trout (Fig. 2.)

Rainbow trout eggs were collected from Madison River fish. These hatched on May 23–27, 1937 and the first food (finely ground beef liver and salmon carcass meal) was offered June 8, just 14 days after the mean hatching period. Fifteen fry were examined for stomach contents, 45 minutes after each morn-

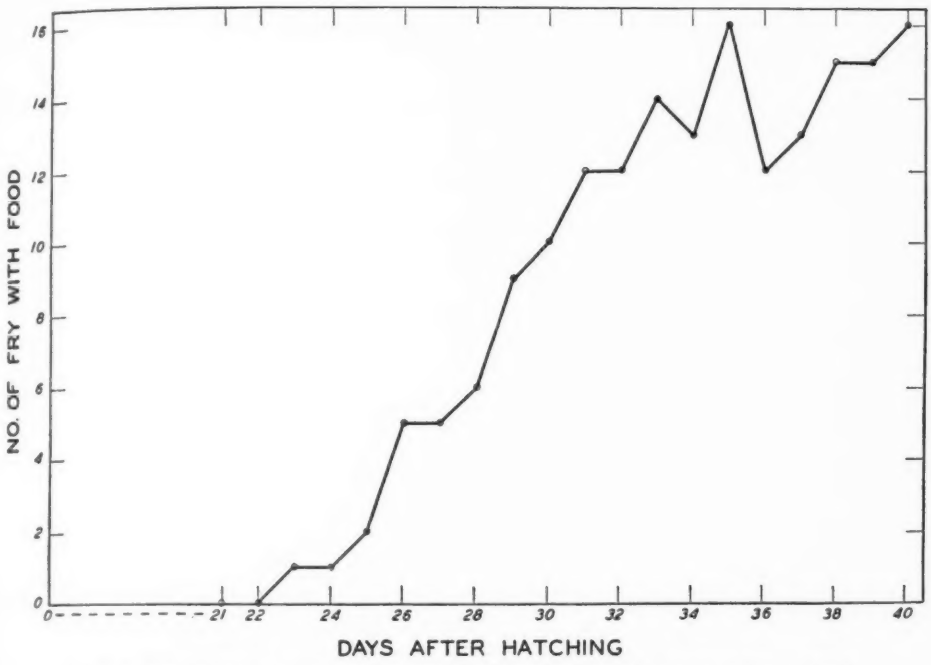

Fig. 4. Time when brook trout fry (*Salvelinus fontinalis*) began to ingest food.

ing feeding. The first stomach contents were observed on the 16th day after hatching and the majority of the fry were feeding by the 20th day. A week later all of the fish examined had stomach contents.

The water temperature varied between 47° and 52°F. during the course of the experiment.

Cutthroat Trout (Fig. 3.)

Cutthroat trout eggs shipped from the Saratoga, Wyoming station of the U. S. Bureau of Fisheries hatched May 7–10, 1937. Food, consisting of finely ground beef liver and salmon carcass meal, was offered 12 days later. Fifteen fry were examined 35–60 minutes after feeding. The first evidence of food in the digestive tracts of these fry appeared two days later or 14 days after the average hatching time. By the 23d day, 100% of the fry were taking food. The water temperature varied between 47°–51°F. during the experiment.

Brook Trout (Fig. 4.)

The brook trout eggs were obtained from the Creed, Colorado station of the U. S. Bureau of Fisheries. They hatched January 8, 1938 and the resulting fry were given their first feeding, consisting of beef liver, 21 days later. This was about one week ahead of the usual hatchery starting time. On the 23d day one of the 16 fish examined had stomach contents. All had food in their digestive tracts by the 35th day.

The water temperature remained almost constant at 52°F. during the experiment.

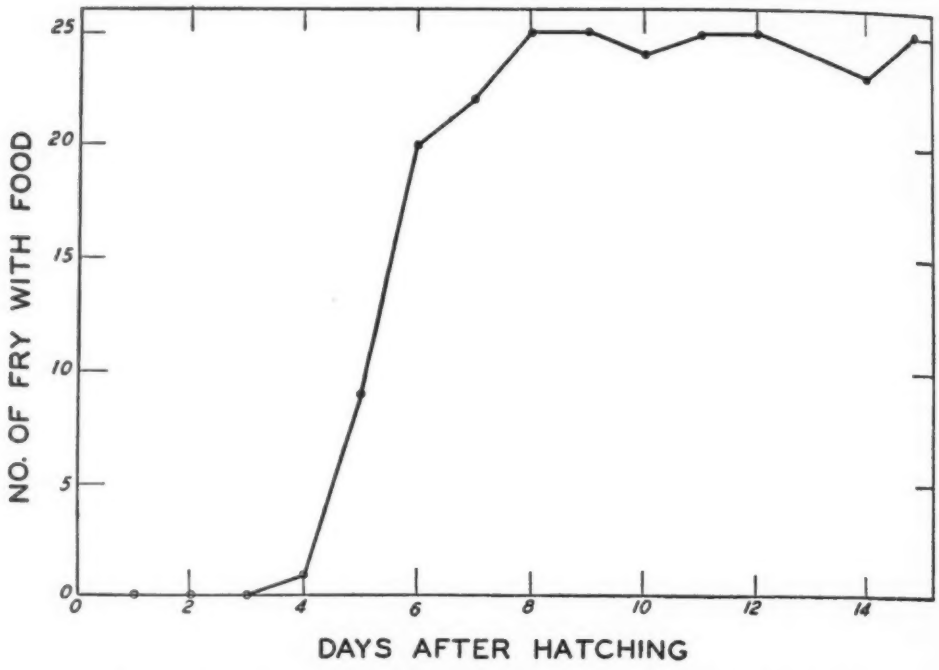

Fig. 5. Time when grayling fry (*Thymallus montanus*) began to ingest food.

Grayling (Fig 5.)

The Montana grayling eggs from Grebe Lake, Yellowstone National Park, hatched June 29. Twenty-five fry were examined 30–45 minutes after the first feeding each day. Food consisting of finely ground beef hearts was presented for the first time on June 30, just one day after the peak of the hatching period. The first evidence of feeding was observed four days after hatching and all fish examined had stomach contents on the 8th day. This is in agreement with a previous experiment by Brown (1938) in which the first evidence of feeding occurred on the 5th day. The water temperature varied between 50° and 52°F. during the course of the above experiment.

DISCUSSION

The trout fry studied showed very little uniformity between species in their initial feeding time. Rainbow fry began to feed first (20 days after hatching) and brook trout fed last (35 days after hatching). The grayling fed much earlier than any of the trout species (eight days after hatching). The interval between the time when a few fry started to feed and when all were feeding is also variable between some of the species. In the brown trout, rainbow trout, and grayling, this interval was four days, in the cutthroat trout 10 days, and in the brook trout 12 days.

THE RELATION OF THE SIZE OF THE YOLK SAC TO THE FEEDING PERIOD

Since the size or disappearance of the yolk sac has been used as an indi-

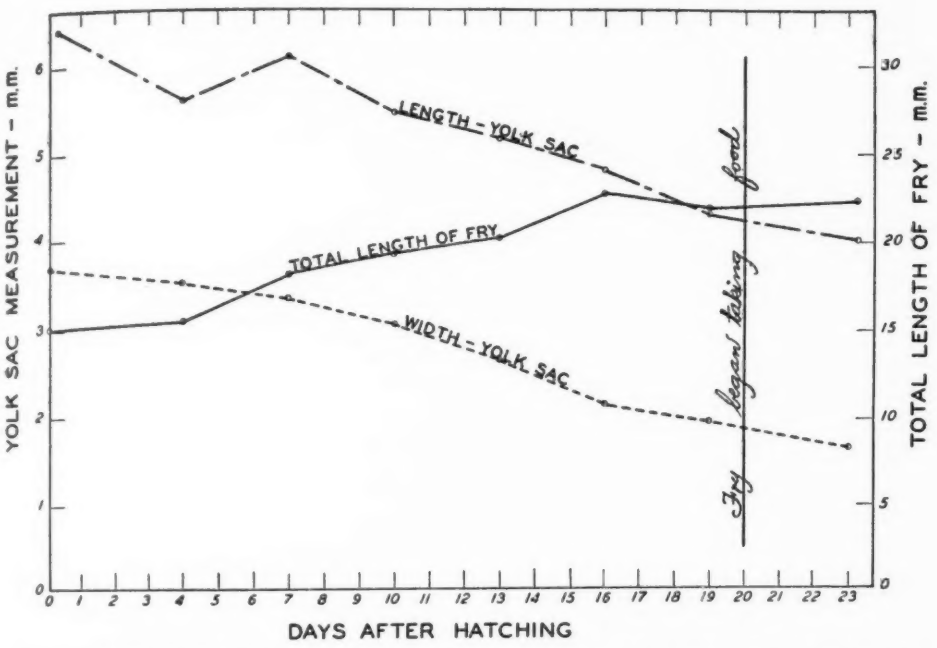
YOLK SAC MEASUREMENT – m.m.
TOTAL LENGTH OF FRY – m.m.
LENGTH – YOLK SAC
TOTAL LENGTH OF FRY
WIDTH – YOLK SAC
Fry beginning taking food
DAYS AFTER HATCHING

Fig. 6. Correlation between the average length and width of the yolk sac and the average total length of rainbow fry of different ages. The cross line represents the first date at which the majority of fry were taking food.

cator for the initiation of feeding, measurements were made on the yolk sacs of rainbow trout and grayling fry of different ages.

The rainbow fry had reached an average total length of 22 mm. at the time when the majority were ingesting food (Fig. 6). At the same period the yolk sac had decreased in length from 6.5 mm. to 4.3 mm. and in width from 3.7 mm. to 2.8 mm. There was no marked change in the yolk sac which could be attributed to the first feeding, but simply the normal reduction in size. Although no measurements were made, the brook trout showed a greater variation in yolk mass during the experiment than any of the other species. In all of the fry studied it was a matter of 1–3 weeks before all trace of the yolk was gone.

The complete reduction of yolk in grayling fry is much more rapid, due to its smaller quantity and the early activity of the fry. Within one week after hatching or at the time when all fry were ingesting food, the average size of the yolk sac had decreased from 8.6 mm. in length to 0.8 mm. and in width from 4.3 mm. to 2.0 mm. At the end of the second week, the yolk of many of the fry had completely disappeared and in the remainder it was present only as one or two small oil droplets.

It is safe to conclude that the size or presence of the yolk sac shows no correlation with the initial feeding time. The size varies greatly during the early

feeding period between species and also between individuals of the same species.

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USE OF CHEMICAL SPRAYS TO INCREASE YIELDS OF FRUITS UTILIZED BY WILDLIFE

Floyd B. Chapman

Most species of fleshy fruits are valuable to wildlife either as foods or as sources of moisture. It is fitting, therefore, that the wildlife manager give serious attention to methods of improving both the quantity and the quality of fruits produced in the wild. In 1935, the writer began a study of wildlife food production and the factors influencing it in southern Ohio. In this paper some of the practical aspects of producing a better wildlife fruit crop are considered. A great many factors are of vital importance in influencing the annual fruit crop. Some of them are climatic, others are genetic, and still others are biotic. It is the last group, consisting largely of insect pests and fungus diseases of plants that will be considered here. Many diseases and insects are even more serious in reducing wild fruit yields than are the climatic factors. Insects and fungi may completely destroy the fruits or cause them to shrivel, dry up, or fall off prior to ripening. The palatability of the fruit may be affected, especially by certain fungi.

The symptoms of many diseases of wild fruits are similar to those affecting cultivated fruits, and in many instances the causative agent is the same. For instance, common apple trees growing on abandoned farms are hosts to a large number of apple diseases and insect pests that are important to the commercial apple grower. Other members of the apple family, as crabapples and hawthorns, are subject to some of the same diseases. Hence these plants, though of very great value to wildlife, are condemned by orchardists as disease carriers. A policy of wild fruit improvement should involve two considerations: first, we must manage apples, crabapples, hawthorns, and related plants if we use them in apple growing regions; second, we should give some attention to the sanitation of wild fruits on other areas even if commercial interests do not demand it. In Ohio we regard the apple as one of the finest of all wildlife foods and have recommended it for planting in refuges and other managed areas. Orchardists insist, however, that we control disease in all stocks used in commercial growing sections.

It was found during the survey that many fruits infested with insect larvae or fungus diseases fell to the ground prior to ripening and were largely lost to wildlife. A small part of the fallen green fruit may be consumed, however. For example, deer were observed to feed on fallen green wild plums. Students of the ruffed grouse have urged the encouragement of more fruit-bearing woody plants on winter grouse range. On some grouse territory inspected by the writer in Ohio there was a sufficiency of woody species that ordinarily hold their fruits until midwinter, but a considerable part of the fruit crop had been destroyed prior to winter by fungi or insects.

Wild grapes are utilized, not only by grouse and songbirds in southern Ohio,

but also by several species of mammals. One of the favorable characteristics of the wild grapes (from the standpoint of wildlife conservation), is their long period of availability, which extends far into the winter. During certain years, however, the wild grapes in our area are subject to severe infestations of the grape berry moth (*Polychrosis viteana*) and most of the fruits fall before ripening. The characteristic symptom of this attack, which is common to both domestic and wild grapes, is premature coloring, after which the fruit cracks open or shrivels and drops to the ground. The most satisfactory method of preventing grape berry moth damage in Ohio has been the use of a lead arsenate spray. This spray is prepared by dissolving 4 level tablespoons of lead arsenate in one gallon of water and adding a soap spreader. The fruit should be sprayed once just after the blooms have fallen, and again about ten days later when the grapes are about the size of BB shot.

In the spring of 1936 we began experiments with sprays on wild grapes, in order to improve the yield and quality of the fruit, and to prolong availability until winter. They were conducted on two species of wild grapes in Odell Game Sanctuary on the Roosevelt Hunting Preserve. One of the species, *Vitis aestivalis*, has rather small fruits which mature early in the fall. The other, *Vitis labrusca*, has much larger fruits which mature later. Ten vines of each species were selected for spraying and ten additional plants of each were used as checks. The spray described above was used. All plants were approximately the same age and were located along a well-lighted road in the sanctuary. On October 1, all grapes were picked from the sprayed and unsprayed vines of *V. aestivalis*, and on October 15, that procedure was repeated for *V. labrusca*. The number of sound grapes per bunch on both sprayed and unsprayed vines was recorded for both species. The results are compared in Table 1.

TABLE 1

COMPARISON OF FRUIT YIELDS ON SPRAYED AND UNSPRAYED VINES OF *VITIS AESTIVALIS* AND *VITIS LABRUSCA* AFFECTED BY GRAPE BERRY MOTH

	Vitis aestivalis (Summer Grape)		Vitis labrusca (Northern Fox Grape)	
	Number of vines	Average Number of grapes in bunch, Oct. 1	Number of vines	Average Number of grapes in bunch, Oct. 15
Sprayed	10	64	10	82
Unsprayed	10	12	10	17

Fruits that had not been sprayed showed the usual marks of attack by the grape berry moth, and most of them turned brown and fell off before ripening. The spray described proved satisfactory in the southern Ohio experiments but may require modification when used in other regions or on other species of grapes.

Obviously the use of chemical sprays to increase the production, quality, and availability of wildlife foods should be conducted cautiously and on a small scale. Wholesale spraying in summer might seriously modify the wildlife habitat involved. As a management tool, chemical sprays will be of most value in sanctuaries and refuges where a high degree of management is practiced.

SUMMARY

A survey of natural wildlife foods and factors controlling their production in southern Ohio indicated that certain insect pests and fungus diseases, some of which attack domestic fruits, are responsible for complete destruction of wild fruits, decreased palatability, premature abscission, or decay before ripening. The wildlife manager might profitably utilize certain chemical sprays, especially in managed refuges, in order to improve the yield and quality of certain fruits, and to prolong their availability into critical periods. The use of a lead arsenate spray on two species of wild grapes gave excellent results in controlling the grape berry moth. Instead of becoming discolored and falling off prematurely, the sprayed grapes remained until midwinter when they were most useful to ruffed grouse, songbirds, and certain mammals.

Floyd B. Chapman
Ohio Division of Conservation
Columbus, Ohio

OBITUARIES

William Hudson Behney, late Director of the Fish and Game Service of the Vermont Department of Conservation and Development, an Associate Member of The Wildlife Society, died from cancer of the colon October 26, 1938, at the age of 36. He was born at Lebanon, Pa.; graduated from high school there in 1925 and from Lebanon Valley College in 1929 with major in biology; spent the summer of 1929 at Woods Hole, Mass., studying fish embryology; received the M.S. degree from the University of Vermont in 1930; was Assistant Professor of zoology there, teaching animal ecology; made a survey of the Huntington River, Vermont, for Chittenden County Fish and Game Club and Vermont Fish and Game Service in 1936. In 1937, and 1938, he had charge of New Hampshire stream surveys. He had published five articles on fish foods and stream surveys.—George W. Davis.

John Nicholas Lowe was born at Princeton, Wisconsin, on October 14, 1886, and died July 27, 1938, from cerebral hemorrhage. He attended Ripon College (A.B., 1910, A.M., 1912) and the University of Wisconsin, receiving the doctorate in 1915. After teaching in several institutions he was appointed Associate Professor of Biology at Northern State Teachers College, Marquette, Michigan, which position he held until his death. Dr. Lowe worked temporarily for several conservation agencies, and was particularly active in fish and game management and in fish surveys in the Upper Peninsula of Michigan.—Carl L. Hubbs.

Dr. John Charles Phillips, an Active Member of The Wildlife Society, died from heart failure while hunting near Hanover, New Hampshire, November 14, 1938. He was born in Boston, Mass., November 5, 1876, graduated from a scientific course at Harvard University in 1899, from the medical school of the same institution in 1904, and from the Boston City Hospital in 1906. He was a student of Professor W. E. Castle and collaborated with him in some of the genetic investigations that so signalized that period in American biology. He never practiced medicine but devoted his time largely to sport and conservation and to writings on these subjects, some of them monumental. "A Natural History of the Ducks" in 4 thick and lavishly illustrated volumes (1926), especially, should be mentioned. For this work Dr. Phillips received from the American Ornithologists' Union the William Brewster Memorial Award for the most important work on American ornithology of its period.

In the World War, Dr. Phillips joined the second Harvard Surgical Unit November 1915 and was assigned to a British general hospital in France. He served with the U. S. Medical Corps from September 1917 to July 1919, when he was a major in command of a field hospital of the Fourth Division. He supported many conservation movements, being President of the League of American Wildfowlers, Director of the National Association of Audubon Societies, for six years President and later Director of the Massachusetts Game and Fish Association, a member of the

Board of Trustees for Massachusetts Public Reservations, Chairman of the Massachusetts Conservation Council, and Chairman of the American Committee for International Wildlife Protection. He was a Fellow of the American Ornithologists' Union, Trustee of the Boston Society of Natural History, President of the Peabody Academy of Science, and Associate Curator of Birds in the Museum of Comparative Zoology.—W. L. McAtee.

NOTES

It is expected that there will be unusual demand for reprints of the reports of the Committee on Professional Standards on "Academic and Professional Training in Wildlife Work," pages 156–161, and on "Publication Standards in Wildlife Management," pages 162–165, so the type will be held for an extended period. The cost of reprints without cover will be $4.15 and $2.40 for the first hundred and $2.20 and $1.40 for additional hundreds, respectively, and they may be ordered from The George Banta Publishing Company, Menasha, Wisconsin.

Notice to authors. The address at the end of a JOURNAL article is meant to be a currently valid one to which applicants can write for reprints or otherwise correspond with the author. The locality where the work was done, if different, or information as to position held at that time, can be specified in the text, or in a footnote, preferably on the first page of the paper.

EMPLOYMENT SERVICE OF THE WILDLIFE SOCIETY

Purpose: This service will be operated as a department of the Journal for the dual purpose of publishing information concerning (1), available positions and (2), qualifications of persons seeking such positions.

Limitations: To conserve the time of officers, the Employment Service will be confined to announcements of openings and statements of the qualifications of candidates. All correspondence will be between prospective employers and applicants, and not with officers of the Society. Appointments to nearly all federal and many state positions in wildlife management are based upon Civil Service ratings. Aspirants should therefore apply to the U. S. Civil Service Commission, Washington, D. C., or to corresponding state organizations for announcements of examinations. Appointing officers are invited to report vacancies and new positions to the Employment Service.

Procedure: Each member will be entitled to one five-line statement of his education, qualifications, and preferences as to type of position in each volume. Additional lines will be charged for at the rate of 5 cents per line, and additional insertions at the same rate for all lines required.

All communications for the Employment Service should be sent to the Editor, W. L. McAtee, Bureau of Biological Survey, U. S. Dept. of Agriculture, Washington, D. C.

Proctor, John R., 5314 Penn Ave. So., Minneapolis, Minn. B.S. University of Minnesota, 1938. Major wildlife management; minor, biology. Graduate work at present. Employment desired in wildlife management.

THE WILDLIFE SOCIETY

Report of the Secretary for the Year Ending with the Third Annual Meeting, February 13, 1939

Regular business of the Society has continued to keep the Secretary fully occupied during the year. The campaign for members continued, with over 4,100 letters of invitation going out to prospects. About 2,000 of these represent persons who had been previously invited to membership, but who had not responded. The prospective membership file has now grown to more than 4,000 cards. Several regional representatives and other members have been particularly active in building up the roster of the Society. This method of getting new members should be more strongly stressed in the future, for every member of the organization comes in contact with persons who would be glad to be acquainted with the objectives of the Society.

The membership rolls now contain 773 names, including those of 303 Active, and 470 Associate, Members. Of these, 71 Associates and 16 Active Members are in arrears for 1938 dues, leaving 686 in good standing. Resignations were received during the past year from 16, while 3 others requested that their memberships be suspended pending return to a more liquid state of finances.

It is the melancholy duty of the Secretary to record the deaths of five members: William Hudson Behney, Stuart Taylor Danforth, Earl Edward Hoover, John Nicholas Lowe, and John Charles Phillips.

Personal history statements from about 50 new Associate Members who expressed their desire to be considered for election to the Active classification were received and forwarded to the Chairman of the Membership Committee. Following the custom previously established, all information about persons recommended for election, as well as about those who previously had not quite reached the standard required by the Membership Committee, were sent the rounds of the Council for review and final action. Consideration has therefore been as complete and impersonal as possible. In addition, the records of approximately 130 Associates considered during 1937 to be the better qualified of this grade but then having insufficient attainments for election to Active Membership, were returned to the Membership Committee for review and consideration of accomplishments since the first examination. A number of these members (22) were advanced to the Active status.

More than 80 libraries, chiefly of Federal and State agencies and of higher educational institutions, subscribe to The Journal of Wildlife Management. This number should be considerably larger; it will undoubtedly increase as the publication becomes better known.

In accordance with the plan approved by the Council, the Regional Representative of Region V was elected at a meeting of Society members in Waco, Texas on November 12, 1938. In all other cases the Secretary conducted elections by mail. These Re-

gional Representatives take office at the close of the 1939 annual meeting. In an effort to get the best possible considered opinion of the members, a nominating ballot was mailed on November 1, 1938. Returns were counted immediately after the closing date a month later. Names of the three persons in each region receiving the highest number of votes were listed on the final ballots mailed December 10 and counted after the closing date for return, January 10, 1939. Elections were as follows:

Region I	Neil W. Hosley
Region II	H. L. Stoddard
Region III	Gustav Swanson
Region IV	Olaus J. Murie
Region V	Charles T. Vorhies (elected at Regional meeting)
Region VI	E. L. Sumner, Jr.

The volume of routine correspondence has increased considerably over that of the preceding year. As previously, the Secretary is grateful for the efficient assistance of Miss Margaret Muehlhaus of the National Park Service staff, who has had entire responsibility for the membership files, subscription business, and all other routine matters.

Among special items of correspondence were those with the Tennessee Valley Authority on the subject of its wildlife policies, and with several agencies with reference to investigation and control of persimmon wilt. The latter subject was pursued in accordance with instructions by the 1938 annual meeting. In response to inquiry immediately thereafter the Chief of the Bureau of Entomology and Plant Quarantine stated that, at that time, little was known of the disease, but studies were being carried out in cooperation with the Bureau of Plant Industry. It was understood that certain officials of the State of Tennessee also were interested and were keeping in touch with developments. Recently, Dr. R. K. Beattie of the Bureau of Plant Industry supplied information on progress. Indications now are that the disease may possibly have been imported from the Orient. Experiments will be performed to determine if one or more Japanese species of persimmon may be immune to the wilt.

Meetings attended by the Secretary during the year were those of the American Association for the Advancement of Science, American Ornithologists' Union, American Society of Mammalogists, National Association of Audubon Societies, Ecological Society of America, Wilson Ornithological Club, and the American Planning and Civic Association's annual meeting and its special conference on the proposed Yellowstone Lake diversion.

Respectfully submitted,

VICTOR H. CAHALANE
Secretary

REPORT OF THE TREASURER FOR THE CALENDAR YEAR 1938

The finances of The Wildlife Society are in very good condition, and there is an increase in the treasury at the end of 1938 of $636.44 over the balance shown at the end of 1937. The year 1937 ended with a balance of $873.29, and the Society started 1939 with a balance of $1,509.73.

It is apparent that dues have come in somewhat faster during January 1939 than they did in January 1938, as on February 1, 1939 a balance of $2,521.85 is shown, which is $1,012.12 over what was on hand a month earlier.

During 1937 general administration of the Society cost $677.92 and during 1938 the cost was $771.09. Of this, postage, registered mail, and telegrams represent the major expense, 95 per cent being for postage. Stationery and printing costs dropped from $313.17 to $206.11. Because of the increase in the amount of work to be done, secretarial assistance increased from $60.00 to $187.05.

As it has been the policy of the Society to use most of its funds for THE JOURNAL OF WILDLIFE MANAGEMENT, the largest cost by far was for this purpose. The cost of the four issues printed in 1938 was $2,051.27. JOURNAL issues increased in cost as follows: January—$231.34; April—$454.66; July—$551.67; October—$813.60. It appears from this, and from the anticipated receipts (55 per cent of the 1939 dues and subscriptions have been paid), that about $800.00, on the average, may be spent for each issue of the JOURNAL during 1939.

FINANCIAL STATEMENT

For the Year 1938

BALANCE (December 31, 1937)		$ 873.29	
RECEIPTS:			
Associate membership dues	$1,521.00		
Active membership dues	1,490.00		
Subscriptions to JOURNAL	447.80		
TOTAL RECEIPTS*		3,458.80	
TOTAL BALANCE AND RECEIPTS			$4,332.09
DISBURSEMENTS:			
General Administration			
Stationery and printing		$ 206.11	
Postage, registered mail, telegrams, etc.		356.83	
Secretarial assistance		187.05	
Room rent—Baltimore, Md.		10.00	
Treasurer's bond		5.00	
Refunds		5.00	
Exchange		1.10	
Publications			
JOURNAL OF WILDLIFE MANAGEMENT (4 issues)		2,051.27	
TOTAL DISBURSEMENTS			$2,822.36
BALANCE (December 31, 1938)			$1,509.73

WARREN W. CHASE,
Treasurer

* Total receipts are not a product of 1938 dues only, as there have been some late 1937 and some early 1939 dues added. The total receipts for 1938 amounted to $2,910.00.

REPORT OF THE MEMBERSHIP COMMITTEE FOR THE PERIOD FEBRUARY 14, 1938–FEBRUARY 13, 1939

The continuity of thought and action of any group of workers banded together by a community of professional interest is dependent very largely on the training, the experience, and the free and resourceful intelligence of its members that can be applied to their mutual problems. In turn, the collective possession of such attributes by any society is determined by the standing and the vision of the men elected to membership. Thus, professional standards for membership become a cornerstone of the Society's structure.

Likewise, until such a group becomes of age and has established traditions to guide it, substantial and honest differences of opinion with regard to professional policies and activities are unavoidable. In this situation, although the Membership Committee should, theoretically, function as a judicial rather than as an executive agency, in the absence of directive executive action it has become necessary as a temporary expedient to combine both responsibilities.

Thus a set of suggested standards, intended primarily to indicate to the Society the qualifications in general utilized by the Membership Committee in classifying applicants was presented in last year's report. It should be emphasized that these were intended primarily to stimulate Society thinking and to clarify discussion on this all-important problem.

No suggestion was contained in this report that the Membership Committee should take any responsibility in the actual setting up of Membership standards. The Committee reiterates its belief that its responsibility should begin and end with the application of standards set up by the Society to the qualifications of the individuals applying for membership.

This has not been possible. The recommendations of the Membership Committee in this regard coupled with the publication of the list of Active and of Associate Members continue to engender some discussion. It seems apparent that opinion has not yet crystallized to the point where the Society is ready to adopt a more specific set of Membership standards. Thus over the past year your Committee has been forced to use as a base the same set of standards suggested in its report last year. The Membership Committee, unwillingly but necessarily, thus had to accept some share of the responsibility for molding the professional requirements for Society membership in its formative stage.

In the application of these standards, particular difficulty has been encountered through the lack of a clear definition of the term, "wildlife field." To those who would interpret it broadly, included among its cultivators would be not only those actively engaged in the study, teaching, or administration of factors which directly influence the distribution, abundance, or well-being of wild animal life, but also individuals recognized for their work along more fundamental or complementary lines of activity. Acceptance of such a definition would admit to active membership in the Society workers in many related

fields such as taxonomy, general ornithology, and comparative pathology. Uninstructed by any clear indication of Society intent in this matter, your Committee has maintained a conservative course by recommending for Active membership only those whose activities are connected rather closely with the management of the wildlife crop. At a joint meeting of the Committee on Standards and the Membership Committee it was decided to recommend to the Society a broad interpretation of qualifications for membership. It would greatly facilitate the future work of the Membership Committee if a clear and concise definition of the wildlife field could be formulated and agreed upon.

The system of multiple consideration of each applicant by each member of your Committee set up last year was continued. Applications numbering about 180, as received from the Secretary, were thoughtfully evaluated by each Committee member. Of these 33 were recommended to the Council as possessing qualifications of Active grade. Every effort to avoid errors in judgment again was made. References and sponsors named on the applications were frequently consulted. Particularly difficult decisions were made the subject of a special discussion with the Council.

Early in September, a group of applications of highly graded Associate members was referred to your Committee for reconsideration by the Secretary. Statements were requested from those whose training or experience qualifications, since the original application was acted upon, might be such as to rate Active membership now. Because of the substantial amount of Committee work involved, and the probability that most applicants will not add sufficiently to their professional stature in a single year, it is suggested that such consideration may well be made biennially. In future years, such revision must, of course, include all associates, not merely those requesting Active rating.

The status of 17 of 129 of those reconsidered had changed sufficiently to permit their recommendation to the Council for election to Active membership. To avoid further misunderstanding, it should be repeated that a number of individuals fully qualified for Active membership have, for various reasons, requested Associate rating.

Despite the rather detailed information requested of each individual wishing to join the Society, a substantial proportion of doubtful cases of membership classification are resolved through familiarity on the part of one or another of your Committee members with the individual's qualifications. The work of the Committee thus may be greatly facilitated through the continued selection for its members of persons likely to be familiar with the background of those wishing to join The Wildlife Society. Included in this classification are those administratively familiar with the larger organizations that train or employ men in wildlife work; the Committee personnel should include at least one ichthyologist. Feeling keenly the lack of such a member, the Committee wishes to record great appreciation of the assistance it has received during the year from T. H. Langlois in judging applications in his field.

The Membership Committee invites

any member of the Society to request reconsideration of any decision involving membership classification.

In considering the standards for Active membership as to experience, as suggested in last year's report, the question has arisen as to just what weight should be given to length of experience. Although the Committee intended that this should be judged in terms of the results accomplished in the wildlife field, this was not clearly stated. We therefore suggest a clarifying revision of the experience standards. For Active membership based on experience (Class 4), standard qualifications might then be described as follows:

A minimum of eight years of substantial and broad experience in the specific field of wildlife management in which the results achieved must demonstrate satisfactory utilization of the opportunity to secure an understanding of wildlife management principles comparable with that gained from the academic training required for similar classification.

The same idea should be incorporated in the other descriptions of experience that determine the classification in which members are placed.

In view of the obvious desirability of maintaining a reasonable continuity of thought and action in the work of this Committee, and the difficulties so far encountered in accomplishing that result, because of the relatively few opportunities for discussing policies and problems, your Committee recommends that the Society give serious consideration to a change in Article III, Section III, of the Constitution.

To insure the necessary continuity, it is suggested that the size of the Committee be increased from five to six members, two to be elected each year to hold office for three years each. This would assure the presence of a larger number of experienced committeemen and would reduce materially the chances of undesirable changes in Committee action resulting from unfamiliarity with past precedents and policies.

As has been said, "It is one thing for a group of workers to claim professional status, it is quite a different thing to assume all responsibility and implications of the term." Prerequisite to this, your Committee feels the need for serious, detached, deliberate study of the problems of defining the wildlife field and of setting up definite Membership standards.

Respectfully submitted,

WILLIAM R. VAN DERSAL
LAWRENCE E. HICKS
ROY KOMAREK
JAMES MOFFITT
GARDINER BUMP, *Chairman*

REPORT OF THE COMMITTEE ON PROFESSIONAL STANDARDS

I. Statement of academic and professional standards

At the Baltimore meeting of the Society in February, 1938, there was established a Committee on Professional Standards, charged with several responsibilities. One of them was the preparation of a statement of professional qualifications that might serve as a guide to persons intending to enter this field of work, and that might also be of interest to institutions training these men.

Discussion of this and other matters by the newly-appointed Committee began on May 7. Aldo Leopold, as chairman of a subcommittee to whom this task was assigned, completed the first draft of a statement of qualifications on May 24; it was sent to the other members of the full Committee on June 1. Since then there has been extensive correspondence among the members of the Committee with reference to this and subsequent drafts. The statement, "Academic and Professional Standards in Wildlife Work," presented with this report for the approval of the Society, is the fifth draft examined by the Committee. While primarily the work of Leopold, it represents also the views submitted by the other members of the Committee; in addition, valuable suggestions have been received from President A. A. Allen, Secretary V. H. Cahalane, Editor W. L. McAtee, and Charles Elton.

Your Committee very early agreed: (1) that at this time the standards of neither the Society nor the profession are sufficiently well established to warrant "ranking" or "accrediting" institutions at which wildlife training is conducted; (2) that even if this were not so, a purely objective evaluation of institutions, based upon courses, equipment, salaries, and the like, would be confronted by so many unknown and variable conditions as to make the result of little value; (3) that the necessities in preparation for wildlife work are best presented primarily to those who are undergoing this training or who expect to do so; (4) that this approach should benefit both the student and the institution.

It is the belief of your Committee that the profession should be most concerned with what a man is, what he knows, what he can do, and how he thinks. The means by which he attains competence in these respects are for him and his institution to determine; there is no formula. For this reason no mention is made of specific courses or curricula; these are listed in the BS-Leaflet published by the Bureau of Biological Survey and mentioned at the end of the Statement.

The Committee recommends the adoption of this Statement by the Society and its publication in THE JOURNAL OF WILDLIFE MANAGEMENT.

II. Civil service

In the belief that there are a number of ways in which the Society can be of assistance in matters affecting both state and federal civil services, it is the opinion of your Committee that this whole problem should be fully and freely considered during the coming year. Since the Committee is not, and should not be, empowered to speak for

the Society on matters of general policy, a report should be presented at the next annual meeting for the consideration of the Society.

As a result of its discussion thus far, however, your Committee has now in mind certain points that should be called to the attention of the Society. No formal action is contemplated at this time. Rather, these are some of the matters that will be discussed further by the Committee and the membership of the Society.

(A) There is now a lack of *adequate* state and federal civil service provision for technical wildlife work. Unfortunately, many states and some federal agencies have no civil service regulations at all.

(B) In many states the civil service regulations discriminate against non-residents. One result of this policy, if continued, might be that in the wildlife field each state must have its own school or must employ untrained men. In the opinion of your Committee, there is every reason to encourage the free interchange of technical personnel among the states.

(C) The present understaffed condition of certain civil service commissions is making difficult, sometimes impossible, the formulation and grading of examinations designed to bring out the fundamental characteristics of wildlife work and of the workers being examined.

(D) The principle of veterans' preference is widespread in the state and federal civil services. There is serious doubt as to the propriety of applying this, or any other principle except that of merit, to appointments in the wildlife field or in related branches of the civil service for which a high degree of training is required.

III. Standards for active membership

By a large majority vote, the Society provided in its constitution for three classes of membership: Honorary, Active, and Associate. Until now the Membership Committee, subject to the approval of the Council, has assumed the two difficult tasks of establishing the basis for Active Membership and of making recommendation in the case of each member.

A year ago the Membership Committee and the Council requested this Committee to review the standards for Active Membership. The resulting discussion, culminating in a joint meeting with the Membership Committee on February 12, 1939, has led to the following expressions of opinion. These are recommended for the approval of the Society and the future guidance of the Membership Committee:

(A) The phrase "wildlife research" (Constitution, Article III, Section 2) should be interpreted broadly. Anyone engaged in the study of wildlife should be eligible to Active Membership, provided his other qualifications are approved by the Membership Committee and the Council.

(B) The Membership Committee should recommend to the Council for Active Membership a person whose record, on paper, does not qualify him for this class when, in the opinion of the Committee, there are other special reasons—such as outstanding accomplishment—for this recommendation.

(C) The Membership Committee should continue to evaluate, as well as

is humanly possible, the record of accomplishment of each prospective Active Member. It is for that Committee to decide, however, whether to give this record a separate rating or to consider it as part of the "Experience" rating now used.

(D) Matters of administrative detail, such as the numerical scale of rating, should be left to the judgment of the Membership Committee.

While there are some inevitable difficulties in maintaining and separating the Active and Associate membership classes, they must remain unless and until the Society chooses to change its basic policy and amend its constitution. Under the present plan the Committee feels that a broad basis of eligibility is desirable: First, because it is virtually impossible to differentiate between wildlife research that bears on management and that, if any, which does not; second, because the comprehensive nature of wildlife work makes highly desirable the inclusion of many types of research within the field embraced by this Society. Wildlife investigation can not be "compartmentalized."

There is no justification for the erection of impassable barriers to Active Membership based *solely* upon such concrete requirements as courses taken, degrees received, or positions held. There are leaders in every field of human endeavor who do not meet specifications of this kind, and provision must be made for their recognition. There are also men who grow with their opportunities, others who do not. At the same time, however, in a field increasingly dependent upon thorough scientific training and technical experience, the "Academic" and "Experience" requirements, as hitherto applied by the Membership Committee, must continue to provide an indispensable measuring-stick for nearly all applicants.

Your Committee recommends the adoption of the ideas expressed in Section III of this report as the sense of the Society.

Respectfully submitted for the Committee.

RUDOLF BENNITT, *Chairman*

COMMITTEE:
Rudolf Bennitt
Frank C. Edminster
Paul L. Errington
Carl L. Hubbs
Ralph T. King
Aldo Leopold
H. D. Ruhl
Herbert L. Stoddard
Walter P. Taylor

ACADEMIC AND PROFESSIONAL TRAINING IN WILDLIFE WORK

(Prepared by Aldo Leopold, Professor of Wildlife Management, University of Wisconsin, with the assistance of, and endorsed by, the other members of the Committee on Professional Standards of the Wildlife Society;* adopted by the Society and publication authorized at the annual meeting, Detroit, Michigan, February 13, 1939.)

Need for standards

Many universities now offer professional training in wildlife work. Many young men are seeking advice on how and where such training is to be had, and how to prepare themselves for it.

As in any new field, there is widespread confusion in finding terms for comparing schools and for imparting advice to those who ask for it.

The Wildlife Society offers this attempt, by a committee of practicing wildlife specialists, to define adequate training for the practice of their profession.

Degrees and kinds of training

Wildlife education has two functions: (1) to teach a few men to manage wildlife as a life work; (2) to teach the whole body of citizens to appreciate and understand wildlife. There is at present a regrettable neglect of the second function. Too many men want to make a living by managing wildlife, too few to bend other vocations to its needs.

For the former there are different levels of training. The warden or "farmer" of wildlife crops requires less schooling than the professional who can appraise methods of cropping and conduct research for new methods. Here again there is a regrettable neglect of the first or vocational level. Too few schools offer good instruction in the field operations of wildlife management and administration; too many offer indifferent training in wildlife science and research.

As a first step toward untangling these confusions, we here attempt to define that kind of training, which seeks to prepare a student for wildlife management as a life work, and which merits the term "professional" or "scientific." We confine ourselves to this one kind and level, not because the others are less important, but because, unfortunately, few schools as yet offer training for such positions as conservation officer or hatchery superintendent.

For the sake of brevity this paper draws its illustrative material largely from land animals. Wildlife, however, also includes aquatic animals. Moreover, to the extent that plants are essential food and factors of the environment of animals, from which they cannot be dissociated ecologically, wildlife includes plants. Where the illustra-

* Frank C. Edminster, Soil Conservation Service, Upper Darby, Penn.; Paul L. Errington, Iowa State College; Carl L. Hubbs, University of Michigan; Ralph T. King, Syracuse University; Aldo Leopold, University of Wisconsin; H. D. Ruhl, Michigan Department of Conservation; Herbert L. Stoddard, Cooperative Quail Study Association, Thomasville, Ga.; Walter P. Taylor, Bureau of Biological Survey, Texas A. & M. College; Rudolf Bennit, University of Missouri, (Chairman).

tive material implies a narrower scope, the reader is asked to interpolate the broader one.

Standards

Professional training is ordinarily defined in terms of years at school, courses taken, and degrees received. The lack of standard meanings invalidates some of these terms for our purposes, especially the lack of standards for specifying courses. The most elaborate curricula may be offered by the weakest schools. We, therefore, cannot define professional training in terms of courses.

Years at school and degrees come nearer having a standard meaning. In general the minimum period for professional training is five years of college work: four years of undergraduate work plus one year of graduate work. Six years is better, seven frequent in the better schools. In general, a master's degree is the minimum for professional standing.

It by no means follows, however, that a student with six years of college work behind him and a master's degree in his pocket is prepared for professional practice. In the following pages we attempt to define preparedness at two stages:

(A) At the time of selecting an undergraduate major.

(B) At the time of completing professional training.

We attempt to express preparedness at these two stages in terms of (1) what the student is, (2) what he knows, (3) what he can do, and (4) how he thinks. A final section discusses briefly the physical equipment of professional schools.

Our hope is that these definitions will enable prospective students to arrive at a critical judgment of their own fitness, and that they will also enable wildlife schools to arrive at a critical judgment of their own adequacy. We hope further that more schools will cultivate their opportunity to impart a general understanding of wildlife to the student body as a whole, and that some will differentiate and develop good training for the vacant sub-professional levels.

It is possible for self-trained men to achieve high professional standing in wildlife management. Such achievement is rare, however, and usually comes only through apprenticeship; *i.e.*, working with highly trained men on the job instead of in school.

(A) *At the time of selecting an undergraduate major*

1. What He Is.

The student should have a reasonably sound physique and a cooperative personality.

2. What He Knows.

The student should have a better-than-average scholastic record, for this is usually an index of intelligence.

In selecting his major for undergraduate work, the student will encounter the question: What biological field offers the best "gateway" to professional training? There is no "best" that can be laid down for all individuals. It is desirable that the profession be recruited from majors in a wide variety of sciences and in the arts of land use. In general, some biological science is the best gateway to a career in research; some agricultural art (including forestry) to a career in policy

or administration. It is a conspicuous fact, however, that men who are narrowly specialized, either by training or temperament, seldom occupy any large professional niche for very long.

The quality of teachers should carry more weight in selecting a major field than the departmental label. The student should select a major, if possible, in a department with definite scholarly achievements in natural science and with a statesmanlike attitude toward land use.

In addition to academic preparation, the student should have attained, by his own efforts, considerable knowledge and field skill in some branch of natural history (such as ornithology, mammalogy, ichthyology, or botany). Animals, plants, and soils are the alphabet of wildlife management; in five years a good school can teach a student to spell words with it, but he must in some degree know his alphabet at the start.

3. What He Can Do.

More than average ability to express thoughts in writing and in speech is indispensable.

Some pre-existing skill in woodmanship, hunting, and fishing is desirable, likewise familiarity with the field operations of farming, forestry, and other land industries. There is danger though of confusing the aptitude for hunting and fishing, which is desirable, with the aptitude for laborious studies of animals and plants, which is indispensable.

4. How He Thinks.

Ultimate professional caliber is a matter of scholarly habits of mind, both indoors and outdoors. The student who "likes the woods but dislikes to study" should be skeptical of his fitness.

The student who feels drawn to the outdoors but has never been impelled to undertake some systematic study of outdoor subjects *on his own account* should not expect a wildlife school to do it for him. That is to say, no wildlife school can make a professional man out of absolutely raw material in five years. Habitual self-teaching is a necessity.

(*B*) *At the time of completing professional training*

1. What He Is.

To the personal qualities already mentioned the student should have added, during the course of his training, an intense conviction of the need for and usefulness of science as a tool for the accomplishment of conservation.

2. What He Knows.

The basic skill of the wildlife manager is to diagnose the landscape, to discern and predict trends in its biotic community, and to modify them where necessary in the interest of conservation. To receive a professional degree, the student should be able to examine a piece of land or water and to deduce (a) its original condition and recent history, (b) the present status of its principal wildlife species and the population trend and behavior of each, (c) the status of its economic uses and their effects on wildlife, (d) the modifications of economic use needed in the interest of wildlife, and (e) the rough outlines of researches needed to refine and verify his diagnosis.

To appraise the landscape the student must know its component parts and something of their interrelationships. That is to say, he must know its

plants and animals, its soils and waters, and something of their interdependences, successions, and competitions. He must know the industries dependent on that landscape, their effect upon it, and its effect upon them. He must know and habitually use visible "indicators" of those slow landscape changes that are invisible but nonetheless real.

He should also have some mental picture of the other professions which are trying to influence that landscape, how they go about their work, and how they help or hinder his own work.

3. What He Can Do.

To get this knowledge, a student must have acquired certain technical skills in field, laboratory, and office operations.

He should have made an inventory and map of the food, cover, and other environmental conditions on a sample area of land or water, and a plan for making that area more productive. He should have executed such a plan for a season and drawn deductions from his experience.

He should have planned and executed an animal census and drawn deductions from it. He should have trapped, marked, released, and retaken animals for the purpose of tracing movements, measuring density, or analyzing the composition of the population. He should have found and observed nests or young and recorded and analyzed mortality.

He should have planned and executed some kind of quadrat for recurrent measurement of changes in vegetation.

He should have reared some animal in captivity. Artificially propagated animals, while probably of diminishing importance as a means of replenishing wild stocks, are often indispensable as controls for experiments on wild animals.

He should have developed some degree of expertness in "reading sign," that is, in determining, by inference from indirect evidence, the kinds, numbers, habits, and status of animals on an area of land or water and their relation to its plants and industries.

He should have become really proficient in at least one field of natural history and should have developed some competence in others. (By "fields" is meant studies of birds, mammals, fishes, reptiles, plants, etc.)

He should have collected and analyzed stomach contents, and, in the field of terrestrial wildlife, pellets and scats. He should have made usable study skins and prepared skeletons, or should have preserved fish specimens and scales for laboratory study. He should have collected and prepared herbarium specimens of land plants, or collected and studied (or prepared for study) the aquatic plants and food organisms of at least two habitats.

He should be able to score 50% of usable negatives in ordinary technical photography. He should know how to use compass, plane table, planimeter, slide rule, and calculator. He should have compiled simple statistics, graphed them, and analyzed them in the light of statistical theory.

He should be able by examination of a carcass to arrive at some notion of its normality or pathology and the cause of death.

He should be a habitual reader of the

current literature in wildlife management, natural history, ecology, and land use. He should be aware of the personalities represented in that literature. He should be able to do library research and to prepare a creditable bibliography. While his knowledge of the literature of his own country will naturally be greatest, he should be aware of the work in all countries, and he should have dug out the essential ideas of at least one foreign group, comparing their work with his own.

He should speak well enough in public to be able to describe his readings, observations, and ideas at professional or conservation meetings.

4. How He Thinks.

These technical skills are the tools for a professional career, but they are useless or even dangerous unless guided by a mind of professional caliber. To create such a mind is the aim of all education, including wildlife education; to define such a mind defies the best efforts of all committees, including this one.

There are indicators of scholarship that are useful but by no means infallible. They are here given for what they may be worth:

One indicator is output. To receive a professional degree, the student should have outlined, executed, and reported on a research project that the faculty is willing to recognize as a contribution to professional knowledge. This means he should have composed an account of his original work good enough to be acceptable to professional journals. (This does not imply that every professional student must rush into print; only that his work be good enough to report in print.)

The student's account of his original work is usually his thesis for a degree. It should not deal merely with a specialty that the student should know to the exclusion of other subject matter. Rather, it is a vantage point, gained by his own effort, from which the student should scan his new professional world and try to understand it.

He should have developed his own views on simple questions of wildlife policy and should be able to expound and defend these views in public. He should have developed some appreciation of the ethics and esthetics as well as of the economics of wildlife.

In viewing the landscape, he should habitually infer its past and foresee its future; that is to say, he should think in terms, not of plant and animal species alone, but of communities; not of types alone, but of successions. In this lies the difference between the static natural history of yesterday and the dynamic ecology of tomorrow.

He should have developed enough familiarity with the basic sciences to know when, where, and how to seek scientific advice on questions arising from his work.

Last and most important, he should have developed in some degree that imponderable combination of curiosity, skepticism, and objectivity known as the "scientific attitude."

Perhaps few of even the leading wildlife specialists of the day would be able to score on all these criteria of professional preparedness which set a high mark but not an impossible one. Professional schools should be able to improve on the fortuitous education of the first generation. The mark of the modern school is that the students out-

score the faculty on many points. It is our opinion that the best students in the best schools can score on almost all the points listed in his paper.

Equipment of professional schools

The foregoing "intellectual tools" cannot be given to students without certain intellectual and physical equipment for teaching.

First of all, no institution lacking output in wildlife research can possibly teach wildlife management of professional grade. To add to the student's knowledge the teacher must habitually be adding to his own. If the teacher has no output, his knowledge is, at best, second-hand.

Second, no institution can teach wildlife management of professional grade without land or water on which ecological experiments are being made, or on which the techniques of management are being tested. That is to say, a school must be practicing management and critically appraising its success before it can teach students to do likewise. The last point is of special importance in wildlife management and it represents a practice that has hitherto been widely neglected.

Third, no institution can teach wildlife management without a suitable library and reference collections in process of active expansion.

It is our belief that mass-education is impossible in the professional wildlife field. Size of school, beyond reasonable limits, is likely to be inverse to quality of training.

The student will do well, in selecting a school, to ask about the character of its faculty, its research output, its management areas, its library, and its reference collections, rather than about its buildings, its curricula, and its appropriations. These are the trappings of scholarship; they mean little without the scholarship itself.

A list of wildlife schools is issued periodically by the U. S. Bureau of Biological Survey, Washington, D. C. The 1938 list is Wildlife Research and Management Leaflet BS-98.

PUBLICATION STANDARDS IN WILDLIFE MANAGEMENT

(Prepared by Paul L. Errington, for the Committee on Professional Standards, 1938.*)

Wildlife management has yet to acquire scientific standing in the estimation of many workers in related biological fields. This may doubtless be attributed in part to the time being not so far behind us when its literature was chiefly the lore of hunters and game keepers. Much that is currently available as "information" on wildlife topics still reflects the recency with which objective research has been employed.

What can be done to improve our literature is one of the matters under consideration by the Committee on Professional Standards. We may commend the efforts of W. L. McAtee in stressing quality in composition; his mimeographed articles on writing for the Biological Survey have wide scientific application and should be readily available to everyone interested. Worthy likewise of commendation is the policy of those journals that reject manuscripts that are weak or prematurely submitted, irrespective of whether written by members of sponsoring organizations.

It is true that rushing into print and kindred practices are not faults peculiar to persons engaged in wildlife management; moreover, a substantial proportion of the technical publications of the latter group come out in journals, bulletin series, etc., devoted to ecology, ornithology, mammalogy, parasitology, and science as a whole, hence are not exempt from the editorial discipline to which the papers of other scientists are subject. Nevertheless, there is strong feeling, within our field and without, that our manuscripts need more strict appraisal and revision before publication than they, as a rule, have received and that a great deal of the responsibility for doing this should devolve upon the authors themselves.

In learning to write, there is no substitute for conscious striving for improvement. Young workers should, in fact, spend much of their time writing as soon as they have worthy material but it by no means follows that anyone, young or old, should assume that manuscripts must be published merely because they have been written. Large numbers of manuscripts conscientiously prepared by experienced scientific writers are never sent to editors for the primary reason that their own creators are not convinced of their merit. These writings are not always discarded outright, but may later furnish convenient phraseology or data for better manuscripts.

Upon completion of a manuscript, we can all afford to take the precaution of asking ourselves whether what we have written *is* a genuine contribution, and whether we have incorporated its substance in the form best adapted to

* Frank C. Edminster, Soil Conservation Service, Upper Darby, Penn.; Paul L. Errington, Iowa State College; Carl L. Hubbs, University of Michigan; Ralph T. King, Syracuse University; Aldo Leopold, University of Wisconsin; H. D. Ruhl, Michigan Department of Conservation; Herbert L. Stoddard, Cooperative Quail Study Association, Thomasville, Ga.; Walter P. Taylor, Bureau of Biological Survey, Texas A. & M. College; Rudolf Bennitt, University of Missouri, (Chairman).

it and to the journal in which publication is desired. It may, therefore, fall within the province of the present Committee to advance opinions as to what constitutes justification to publish and to offer suggestions that may be concrete enough to be useful and yet not unduly rigid.

Mature Papers and Monographs

The limitations of the human mind and the intricacies of natural phenomena are such that we may legitimately doubt that there ever will be truly mature scientific writing. That, however, should be no argument against working to bring our manuscripts up to as high a level of perfection as we are able and to present effectively the subject matter covered, extracting from the data in hand as much meaning as seems justified.

A monograph comes closest to being "the last word" on a given subject that an author is likely to write unless he continues the research upon which it is based or actively keeps in touch with the pertinent literature other investigators may subsequently produce. It should always be the fruit of years, but years alone do not assure the maturity that should characterize it. A piece of technical writing achieves maturity in proportion to the diligence and impartiality of the author's search for the truth; to his success in assembling and summarizing data of reliable origin and statistical adequacy; his segregation of the basic from the inconsequential; his recognition of varying degrees of significance; and the thoroughness with which he tests his statements and conclusions, one by one, modifying, eliminating, and making allowances for errors in technique or interpretation and for the infinitely great that he does not know.

Papers do not have to be as ambitious in scope as monographs, however, to be entirely acceptable contributions. Indeed, it may be desirable that an author planning to write a monograph first publish shorter papers on special phases of his investigations before beginning the main treatise; by so doing, he may not only record data that he could not advantageously present in necessary detail in the monograph, but he may also, through resulting contacts with other workers, learn much that he might not otherwise learn of shortcomings both in data and interpretations.

While the more exhaustive life history or ecological researches may take three to five years or more to produce publishable data, some lesser side-studies may in a single season yield about as much as may ever be expected from them. In instances of the latter sort the findings, if valuable, should be put in print, although possibly in the form of notes rather than papers.

Publications on Incomplete Studies

Timeliness of interest and utility to other workers may warrant a certain amount of early publication in the course of an important investigation. The danger of readers mistaking tentative views and apparent trends of data for established facts must always be guarded against, particularly if the findings are spectacular and lend themselves to popularization. On the other hand, the problems of conservation are often so acute as to demand whatever guidance may be immediately avail-

able; during the first stages of the waterfowl crisis, for example, publication of virtually any trustworthy information on ecological requirements of wild ducks was in order.

In contrast with the situation in some fields in which techniques have become so standardized that descriptions of them are seldom published, the need for new methods and adaptations of old ones is acute in wildlife research and management. A correspondingly greater part of our technical literature is accordingly devoted to papers illustrating procedure as well as findings, as relates to the handling of data as well as to field and laboratory work. One of the aims behind the founding of The Wildlife Society and its JOURNAL OF WILDLIFE MANAGEMENT was creation of a suitable outlet for papers on technique. Since we lay our foundations much as we go, the Committee feels inclined to advocate publication of this kind of material without unnecessary delay, assuming, to be sure, that the authors really "have something."

Progress reports required by statute or agreement manifestly must be prepared, be they contributions to knowledge or not, but usually their nature is evident and they are published by sponsoring agencies. In a similar class belong many articles and papers requested by editors of periodicals or by program committees of scientific or conservation meetings. Preparation is frequently on short notice, and, an impending deadline being scarcely conducive to leisurely digestion of new data, the cautious writer may find it safest simply to present results as preliminary, or to review previous work.

Notes in Scientific Journals

A note is not commonly expected to have the maturity and weight of a paper but there is no hard and fast difference between the two and the difference is not always one of length so much as of content. The editors may decide to print as papers manuscripts submitted for notes or may recommend the converse to authors.

A major function of a note is to make accessible to technical readers such bits of useful information as one may acquire by chance, incidental observation, and studies of limited or interrupted duration. Old field notes are one of the best sources of material bearing upon little known or controversial topics. Details of animal behavior, glimpses into the workings of complex natural relationships, observations on phenomena associated with severe emergencies or unusual mortality—these are some of the bases from which significant notes may be prepared.

A note, too, despite its brevity, should be written with care. It does, after all, represent scientific writing, and the author is as responsible for what he states in it as in a more pretentious publication; simplicity and conservativeness are still virtues to be sought.

Concluding Remarks

Were this Committee to attempt to say precisely what should and should not be published, it would find itself on exceedingly dangerous ground. Frankly, we, as individuals, do not feel qualified to pass final judgment upon much that is published even in our own fields. We should not be laid open to

accusations of prejudice, unprogressiveness and the like, however, for saying that, whatever may be the merit of a great many contributions, there are few of them that could not, to their own betterment, have taken up less space. This statement is made with full awareness that some authors may go to the other extreme and, through overcondensation, seem unconvincingly to make flat assertions without support of either data or citations.

The slowness with which the mind assimilates concepts at variance with accustomed thought may occasionally justify considerable repetition in scientific writings so long as the author avoids leaving the impression that his findings are more broadly applicable or less subject to other interpretations than they are. Repetition in popular articles based upon published technical papers also may be necessary, though an author may be charged with "spreading his butter too thin" in his efforts to accommodate editors or sincerely to try to make his work useful and understood.

Finally, the Committee may reiterate that the real burden of improving the literature on wildlife management rests upon the authors. The criteria here cited by which contributions may be judged may be imperfect, but, at any rate, they should encourage authors to scrutinize their manuscripts very, very critically before they consider them completed.

MINUTES OF THE THIRD ANNUAL MEETING AT DETROIT, MICHIGAN, FEBRUARY 13, 1939

The meeting was opened by President A. A. Allen at 8:30 P.M., with an attendance of approximately 120 persons. The reports of the Secretary, Treasurer and Editor were approved. The President then called for reports of the Regional Representatives. Neil W. Hosley, for Region I, stated that approximately 30 members attended a dinner and business meeting in Boston at the time of the New England Game Conference about two weeks previously, adopted a set of By-laws and arranged for a meeting next year. William J. Howard made a brief report on membership in his area (Region II) stating that about 90 letters were sent to prospects. He recommended the holding of a sectional meeting, but stated his belief that a large membership in Region II cannot be built up due to the comparative scarcity of trained workers. Samuel A. Graham reported following up the membership campaign in Region III and made a brief summary of the Columbus, Ohio, sectional meeting. The Regional Representative for Region IV (P. S. Roberts) was not present but Adolph Murie transmitted the suggestion of his brother, the newly elected representative, that a meeting be held sometime during the summer in Jackson Hole. Walter P. Taylor gave a brief account of the Region V meeting at Waco, Texas, in November, 1938. E. Lowell Sumner, Jr., was not present and no report was made for Region VI.

Chairman Leo K. Couch read the report for the Committee on Arrangements for the 1939 meeting. During brief discussion of publication of papers read at the North American Wildlife Conference, McAtee suggested the addition of an index to the Transactions.

President Allen named the personnel of a Resolutions Committee as follows: Warren W. Chase, Chairman; F. M. Baumgartner; M. D. Pirnie; L. C. Stegeman; Willis King.

V. H. Cahalane summarized the principal achievements and conclusions of the Council meeting of the previous day and reported to the meeting the Council's recommendation that the Bureaus of Entomology and Plant Quarantine and of Plant Industry be urged to continue studies of the persimmon wilt and that the National Wildlife Federation be urged to take further action. This matter was placed in the form of a resolution, which was adopted. The subject of a house organ received much discussion. It was finally voted to issue such a publication to all classes of members for a trial period of one year. The cost was limited to $250, and the bulletin placed under the guidance of a committee composed of the Editor, the Secretary, and one other member to establish policies, choose an editor, and arrange all details. A resolution was adopted approving the Council's recommendation that the full amount accruing under the Pittman-Robertson Act should be expended for the purposes of the Act. It was also voted to establish the policy that action in defense of alleged interests of individual members of the Society should not be taken *unless* the welfare of the profession is involved. The meeting

ordered that the Editor should print in THE JOURNAL OF WILDLIFE MANAGEMENT an obituary of each deceased member, to be as brief as possible consistent with presentation of the salient facts of the member's life and accomplishments. President Allen then described the need of the Council for authority to move in matters needing early action and the meeting adopted the Council's resolution "that the attitude of the Society on public questions involving wildlife, or the wildlife profession, should be determined by the Council." It was decided to hold the fourth annual meeting of the Wildlife Society at the same time and place as the next North American Wildlife Conference. The Secretary then read the Council's nominations for the Membership Committee, as follows: W. R. Van Dersal, Chairman; C. J. D. Brown, Richard Gerstell. It was voted to instruct the Secretary to cast the unanimous ballot of those present for the entire slate. Contingent upon agreement of the members most affected, it was directed that the northern portion of the boundary between Regions I and III be altered to coincide with the provincial boundary between Quebec and Ontario.

President Allen described the need for an employment committee of five members, geographically distributed, to formulate and put into effect measures to improve the present employment situation and to appraise the future of employment in the wildlife profession. Upon question of the amount of expense involved, McAtee suggested that the expenses of the Committee be paid on approval of the President. He reported that the present system of advertising employment needs in the JOURNAL had been fairly successful as about half of those so advertising during the past year were thereafter employed. It was added, however, that public advertising was distasteful to some and the thought was expressed that the Society should endeavor to effect the best possible means of promoting employment among its members. It was then voted to establish the Committee on Employment, as well as a Committee on Constitutional Revision to consider and recommend to the Council any desirable revision of the Constitution and By-laws.

Chairman Rudolf Bennitt presented the report of the Committee on Professional Standards, including recent corrections and additions by Committee members. Publication of Part 1 in the JOURNAL was ordered, and the Committee continued indefinitely. President Allen thanked and congratulated the Committee on having done a fine piece of work.

Chairman Gardiner Bump presented the report of the Membership Committee. The President stated his opinion that Bump had worked hard and faithfully and informed the meeting that he had asked to be relieved from his chairmanship.

P. D. Dalke, as Chairman of the Auditing Committee, submitted a report approving the Treasurer's annual statement.

On request of a number of members, the Secretary read the list of Active Members elected since the 1938 meeting as follows: Allison, M. N., Atwood, E. L., Austin, S. W., Bissland, Howard Ross, Cowan, I. M., Darrow, Robert W., Davison, Verne E., Enders, Robert

K., Evans, T. R., Friley, C. E., Jr., Haecker, Harold H., Henderson, Walter G., Hoover, Earl E. (posthumous), Hubbs, Carl L., Hunter, R. P., Lehmann, Valgene W., Lewis, Harrison F., McMurtrey, Marvin S., Mast, D. R., Moore, E. B., Musser, Egbert G., Needham, Paul R., Pulling, Albert Van Siclen, Scott, Thomas G., Selko, Lyle Frederick, Weaver, Richard, and Wickliff, Edward L.

Chairman Ruhl presented the report of the Nominating Committee and the President appointed Howard and Van Dersal as tellers. The results of the voting were as follows: President, Aldo Leopold; Vice-President, Carl L. Hubbs; Secretary, V. H. Cahalane; Treasurer, Warren W. Chase. H. L. Stoddard, by unanimous ballot, was elected Trustee for the term to expire in 1942.

The Resolutions Committee chairman introduced resolutions urging support for adequate restoration measures for caribou in Minnesota and of appreciation for courtesies extended by the Hotel Statler. These were adopted and the meeting adjourned at 11:50 P.M.

VICTOR H. CAHALANE,
Secretary